# FURBEARER STUDIES IN THE LIARD RIVER VALLEY BRITISH COLUMBIA; 1980 WINTER SURVEY

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PRELIMINARY

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## ABSTRACT

A baseline inventory of furbearing mammal populations and their commercial harvest in the Liard River drainage was conducted for British Columbia Hydro and Power Authority to support an impact assessment of a potential hydroelectric development. This study is basically an extension of a previous survey of furbearing mammal populations in the Western portion of the study area conducted by McCourt Management Ltd. in 1979.

Populations of fourteen species of furbearing mammals occur in the Liard River drainage. Red squirrel and marten were the most abundant species recorded during winter track-count surveys and reported in fur harvest retruns. Beaver, muskrat and lynx are harvested in the region in moderate numbers. Ermine, weasel and mink populations appear to be locally abundant. Field studies and fur harvest returns indicate the fisher, river otter, wolverine, coyote and red fox populations occur in relatively low numbers. Reported estimates of wolf densities, ranging from wolf per 85 to 171 $km^2$, and numerous sightings in the Liard River region indicate wolves are common in the study area. The snowshoe hare population was moderately abundant during the 1980 field studies and appears to be in the declining phase of its abundance cycle.

Marten and lynx were the more economically important furbearers contributing 36.4 and 29.8 percent of trapper's income on twenty reporting traplines. Beaver, wolf, and red squirrel (in order of monetary importance) made up the bulk of the remaining income (26.7%) from the fur harvest. The annual value of fur harvested on twenty traplines was $90,790.15 (based on an average of 1978-79 and 1979-80 prices). This represents 2.6 percent of the average provincial total, proportionately more than would be expected from the size of the reporting

traplines in the study area. The average and median income per trapline was $4,539.51 and $4,032.14, respectively (a range of $814.33 to $12,844.49).

The main adverse impact of the proposed development on furbearing mammals will occur from habitat alteration and loss during vegetation clearing and reservoir flooding. These habitat losses will result in a reduction of animal populations in proportion to their density and the amount and importance of habitat made unavailable. Construction activities, new access roads, transmission lines, increased traffic and increased access will affect furbearers through habitat alteration and habitat loss, disturbance and direct mortality.

The reservoirs will be permanent structures and the resulting habitat loss will result in a permanent reduction in the populations of different species of furbearing mammals. The reduction in the population sizes would approximate one percent of the regional population (The Liard River drainage) for terrestrial furbearers such as red squirrel, ermine, weasel, marten, fisher, coyote, red fox and lynx and greater than one percent for species which are dependent on wetlands and valley bottom habitats (wolves and aquatic furbearers: beaver, muskrat, mink and river otter).

The most effective measure to reduce impacts on furbearers is the selection of the least detrimental hydroelectric scheme. Scheme 8 is considered to have the least overall impact on furbearing mammals because of its relatively small reservoir areas (69,100 ha).

Additional mitigation of adverse impacts include: limiting vegetation clearing at intensive land-use facilities, roads and transmission lines, immediate reclamation following construction of facilities,

management of reservoir water levels to encourage shoreline habitat development suitable for aquatic furbearers, development of solid waste and industrial waste disposal procedures, and assistance in the development of fur management strategies to protect furbearing mammal populations from over-harvest in newly accessible areas.

The main impacts of the proposed development on furbearing mammal resource use will stem from the reduction in furbearing mammal populations. This will affect trappers, recreational hunters and non-consumptive user groups. Development activities plus new access may result in interference with trapline operations. Thirteen traplines will be directly affected by reservoir flooding; approximately two to three percent of the land area of these traplines will be lost. Measures to reduce the impact on furbearer resource use include: limiting the amount of habitat destroyed by the development (i.e. selection of Scheme 8), and B.C. Hydro's initiative to provide advance notice to trappers when developments are planned in their trapping area. B.C. Hydro should apply the Registered Trapline Program to provide a fair compensation for trapper's losses.

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British Columbia Fish and Wildlife Branch
R. Daloise, Conservation Officer, Fort Nelson
G. Pearson, Conservation Officer, Cassiar
B. Bailey, (former) Conservation Officer, Cassiar
B. Lincoln, Regional Wildlife Management Biologist, Okanogan Region
B. Saunders, Fur Biologist, Victoria
J. Elliot, Regional Biologist, Fort St. John
B. Webster, Wildlife Technician, Fort St. John

British Columbia Hydro and Power Authority
L. Goulet, Environmental and Socio-Economic Services, Vancouver
S. Hirst, Environmental and Socio-Economic Services, Vancouver

Trappers
R. Puttonen, Lower Liard River Lodge

R.L. and L. Environmental Services Ltd., Edmonton.

## 1.0 INTRODUCTION

British Columbia Hydro and Power Authority is examining the feasibility of a hydroelectric development on the Liard River, British Columbia. The proposed development would entail the construction of two or three dams on the main stem of the Liard River. Two objectives of B.C. Hydro's environmental impact assessment program on the Liard River Project are to define the wildlife resource base of the proposed development area and to assess the probable impacts of hydroelectric development on wildlife populations.

McCourt Management Ltd. was commissioned by B.C. Hydro and Power Authority in September, 1980 to conduct a winter inventory of furbearing mammal populations in selected portions of the development area and to assess the probable impacts of reservoir flooding and other project activities on furbearer habitats and populations. This study is essentially an extension of the previous survey on furbearing mammal populations on the Liard River made in 1979 by McCourt Management Ltd. (Penner 1979). The methodology for field studies and reporting style are similar to the 1979 study to facilitate comparison of data between years. Detailed descriptions of furbearing mammal habitat requirements presented in the 1979 report will not be repeated. Instead, emphasis will be given to the comparison of study results between years and discussion of animal habitat use in the study area.

Field work for this study was conducted during December 2 to 17, 1980 along the Liard River valley and tributaries between Site A and Site J. During the 1980 field studies emphasis was placed on sampling areas and vegetation types east of the Liard River Hot Springs which are not accessible by road and sampling lowland and wetland habitat types for semi-aquatic furbearers (mink and river otter) which are known

to be trapped in the study area but occurred in low densities during the 1979 field studies. The use of helicopter transport facilitated access to sample vegetation types east of the Liard River Hot Springs and along the Kechika River that were not present in the western portion of the Liard River valley that was sampled in 1979.

## 1.1 Objectives

The scope of the 1980 winter furbearer studies was defined by the following objectives:

1. to conduct intensive field studies on selected, representative sample areas to determine the relative densities of various species of furbearers. Priority will be given to furbearer species and habitat types that were not previously sampled,

2. to relate the relative abundance of each species of furbearer to the available habitats and distinguish between habitats which are of major life history importance and those used seasonally,

3. to summarize the use of furbearers within the study area from provincial records of registered traplines and provide estimates of the trapping intensity and economic value of the fur harvest,

4. to predict the probable impacts of hydroelectric development on both furbearer populations and commercial use of furbearers in the study area and to distinguish, where possible, between impacts brought about by alternative river development plans and secondary project actions, and

5. to identify feasible mitigatory and compensatory options which might be practical to offset the predicted adverse effects of hydroelectric development on furbearing mammal populations and their commercial harvest.

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## 2.0 THE STUDY AREA

### 2.1 Location

The study area for the 1980 winter furbearer track-count survey included portions of the Liard River and tributary valleys between Site A and Liard River Hot Springs, and the Fishing Lake and Kechika River valleys (Figure 1). Sites for furbearer track-count transects were located at various locations along these drainages to distribute sampling effort in different forest and wetland habitats. Sites were generally within the zone that would be flooded by the Site A or other dams.

The area examined for fur harvest records from registered traplines include all traplines adjacent to the Liard River in British Columbia (Figure 1).

### 2.2 Physiography and Vegetation

A broad description of the physiography and vegetation of the study area is given in Penner (1979).

Vegetation, terrain and wetland types recognized in the study area during the 1980 winter furbearer track-count surveys are described in Section 3.1, Habitat Classification.

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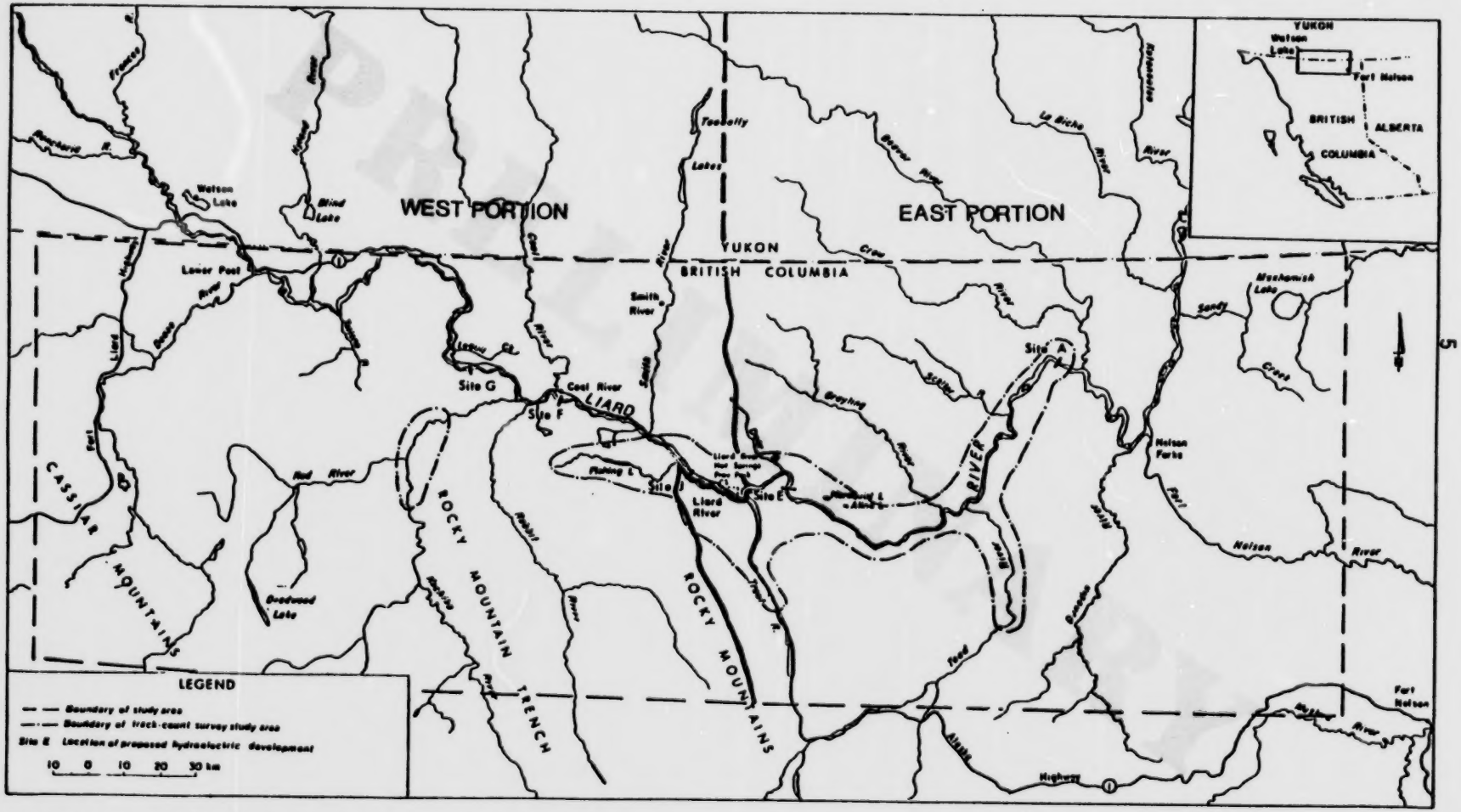


Figure 1. Location of study area for the 1980 winter track-count surveys and the trapping areas examined for fur harvest records, Liard River drainge, British Columbia.

# 3.0 METHODOLOGY

## 3.1 Habitat Classification

The vegetation, terrain and wetlands in the study area were categorized as types to provide a basis on which to evaluate the relative importance of each type to populations of different species of furbearing mammals. The use of one or more vegetation types, terrain types and/or wetland types by an animal will be referred to as its habitat (Odum 1971).

### 3.1.1 Vegetation Types

Terrestrial vegetation types were identified on the basis of dominant species (trees, shrubs and/or herbaceous plants) and classified by grouping plant communities of similar species and structural composition. Emphasis was placed on vegetation or cover types that are recognizable during winter and comprised of plant species and structural composition to which furbearing mammals would respond. This classification is based on and comparable to the vegetation types put forward by Techman Ltd. (1980) and B.C. Hydro(L. Goulet pers. comm.).

Table 1 lists the vegetation or cover types recognized as components of furbearing mammal habitat in the Liard River study area. Several types were combined during data analysis of furbearing mammal use of vegetation types due to low sample size or similarity of cover types and animal activity. For example, the small amounts of lodgepole pine and mixed pine-spruce forest types on track-count transects were combined with the coniferous mixedwood forest type for analysis of animal-vegetation type relationships.

Table 1. Vegetation types recognized during the winter furbearing mammal track-count survey.[a]

| | |
|---|---|
| | Alpine Zone |
| 01 | Alpine tundra - generally above treeline, may contain krumholz |
| 02 | Alpine shrubland - generally high elevation |
| 03 | Alpine fir forest - a high elevation forest type |
| | Upland Zone |
| 04 | Black spruce wetland forest |
| 05 | White spruce forest |
| 06 | White spruce - black spruce forest |
| 07 | Spruce - Lodgepole pine forest and pine - spruce forest, which may contain white and/or black spruce. |
| 08 | Lodgepole pine forest |
| 09 | Coniferous mixedwood forest |
| 10 | Deciduous mixedwood forest |
| 11 | Deciduous forest - primarily aspen; some paper birch |
| 12 | Burn with lodgepole pine regeneration (primarily pole-sized 10 cm dbh) |
| 13 | Burn - primarily low to tall deciduous shrub cover, pole-sized aspen and small conifers |
| 14 | Burn - primarily low shrub and herbaceous cover |
| 15 | Open slopes - primarily a grassland with less than 50% shrub or tree cover |
| | Floodplain and Riparian Zone |
| 16 | Deciduous forest - primarily balsam poplar (cottonwood) |
| 17 | Mixedwood forest - balsam poplar, white spruce and/or alpine fir |
| 18 | White spruce - Alpine fir forest |
| 19 | Riparian tall shrub - grassland |
| 20 | Riparian low shrub - grasslands or meadows |
| | Other Cover Types |
| 21 | No cover - waterbody |
| 22 | No cover - bare rock or soil disturbance |

[a] All vegetation types follow the 25% - 75% composition limits.

### 3.1.2 Terrain Types

The following terrain types were used during winter track-count surveys:

1. Wetlands - wetland and shoreline types are described Section 3.1.3.

2. Riparian/Valley bottom - terrain influenced by alluvial soil deposition, a high water table or periodic flooding from the adjacent wetlands.

3. Flat to undulating uplands including alluvial terraces no longer subject to flooding, and 0 to 10% slopes.

4. Slopes of 10 to 30%.

5. Slopes of 30 to 60%.

6. Slopes greater than 60%.

For slope categories 4, 5 and 6, the major slope aspect was recorded: north facing, east facing, south facing or west facing.

### 3.1.3 Wetland Types

The parameters used to categorize wetland habitat types are relative size and flow regime of the waterbody, the substrate type and the type and extent of aquatic vegetation. Aerial photographs and field observations were used during wetland habitat classification. The following wetland types were recognized in the study area:

F1 Wetlands - relatively narrow (less than 5 m wide) permanent or intermittent streams typical of foothills and mountain drainages. Valleys are generally "V" shaped. Stream depths and flow rates are extremely variable with season and generally contain pools and riffles in varying proportions and sand and gravel to boulder substrate. Aquatic vegetation is sparse to absent. Shorelines are often cutbanks and are generally treed or support riparian tall shurb vegetation.

F2 Wetlands - moderate to fast flowing streams and rivers in the range of 5 to 20 m wide. Water depth is variable but shallow enough to have riffles and pools, sand and gravel bars during periods of low water. Reaches of braided streams are occasionally found along this type. The streams may meander or be incised in a floodplain. While beaver may construct dams on this type during fall and winter, these dams are normally breached by spring freshets and summer flows. Aquatic vegetation is sparse or absent.

F3 Wetlands - relatively large, moderate to fast flowing streams and rivers, generally wider than 20 m, that are generally confined to one or more well defined channels which are encised in a floodplain. Water depths and flow rates are extremely variable as evidenced by extensive gravel bars. These rivers generally have some reaches with pools and riffles and form rapids in constricted areas.

F4 Wetlands - relatively slow flowing streams which are freely flowing only during freshets; otherwise they resemble standing water wetlands. This type often contain beaver dams which further constrict flows and may cause the shallow flooding of adjacent areas. The substrate is generally fine and supports varying amounts of emergent and submergent vegetation.

F5 Wetlands - include backwater channels and oxbow lakes. These wetlands are generally flooded during spring freshet and summer flows and may retain low flow rates during other seasons. Substrate and aquatic vegetation are variable depending on the type and flow characteristics of the associated river or stream.

F6 Wetlands - standing water wetlands including woodland lakes to open marshes.

Shoreline types associated with the above wetlands were categorized as follows:

1. Cutbanks of 1 m to 3 m above water level,
2. Steep rocky or soil slopes that extend greater than 3 m above the water level,
3. Gravel, sand or silt bars,
4. Shorelines vegetated with riparian forest or tall shrub vegetation to within one meter of water level,
5. Narrow to wide margin of emergent aquatic vegetation.

## 3.2 Winter Track-count Surveys

Winter track-count surveys were conducted in the study area from 2 to 17 December, 1980. General sampling sites were selected to distribute sampling effort in selected locations along the Liard River and tributary valleys between Site A and Liard River Hot Springs plus in the Fishing Lake and Kechika River Valleys (Figure 2). At each sampling site, transects were located on the basis of representative vegetation, terrain and wetland types. All transects were

walked along a predetermined course generally requiring a compass bearing. The exact location of transect lines were recorded on 1:50,000 topographic maps and 1:31,680 aerial photographs. The habitat types encountered along each transect were classified by field observations, assisted by forest cover and topographic maps, and recorded on aerial photographs. The linear distance of each transect through each vegetation, terrain and wetland type was measured from aerial photographs and 1:50,000 topographic maps.

During the track-count survey, the following data were recorded for each track of a furbearing animal which was made since the last major snowfall: transect number, animal species, vegetation, terrain and/or wetland type, and the number of days since the last snowfall.

The track-count data was analyzed for each species of furbearer to provide an index of population density as tracks per km-day[a] according to the following formula:

$$\text{tracks/km-day} = \frac{\text{number of fresh tracks of each species}}{\text{distance (km) surveyed X days since last snowfall}}.$$

Population density indices were calculated for each vegetation, terrain and wetland type for all transects in the study area combined. Population density indices were also calculated for groups of transects in different regions sampled (e.g. Toad River valley, Site A area, Norquist Lake area etc.) to determine if there were regional differences in furbearing mammal populations.

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[a] km-day represents the sum of distance (km of transect) multiplied by the number of days since the last snowfall. This calculation reduces the field observations to a common temporal and spatial denominator.

The procedure for statistical analysis of animal-habitat associations followed the methodology described by Neu *et al.* (1974). The hypothesis considered that each species utilized the various vegetation, terrain and wetland types in proportion to availability[a], a multinomial distribution (Ostle 1963).

The value "tracks/day", was calculated for each habitat category as the sum of tracks of a particular species divided by the days since the last snowfall. This calculation reduced the field observations to a common temporal denominator.

The Chi-square test (Steel and Torrie 1960), to determine the goodness-of-fit, compared the overall observed and expected frequency distributions of furbearer tracks/day in different vegetation, terrain or wetland types for each species of furbearing animal (Appendices 2 and 3). Expected distributions were equivalent to the proportions of each vegetation, terrain or wetland type available. Expected frequencies were calculated according to the following formula:

$$Te^{i} = \frac{D^{i} \times To^{i}}{\Sigma D^{i \ldots j}}$$

Where $Te^{i}$ = the expected tracks/day in the $i$th habitat category[b] $D^{i}$ = transect distance in the $i$th habitat category; $\Sigma D^{i \ldots j}$ = total of transect distances in all habitat categories and $To^{i}$ = observed tracks/day in the $i$th habitat category. If a significant difference was found between the two distributions then it was concluded that the animals were not utilizing the habitat in proportion to its availability and further testing could be conducted on the preference for or avoidance

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[a] availability was determined from the distance of each vegetation, terrain or wetland type surveyed on track-count transects.

[b] habitat categories refer to vegetation, terrain or wetland types.

of various habitat types. Conversely, if no significant difference occurred between the observed and expected distributions, it was concluded that these animals were distributed in and utilized the habitats in the study area in proportion to their availability.

Where a significant difference between habitat availability and animal distribution occurred, the Bonferroni statistic was applied to the observed values, providing confidence intervals for each habitat type (Neu *et al.* 1974). Confidence intervals were calculated according to the following formula:

$$\bar{p}^i - z(1 - {}^{a}/2)\sqrt{\bar{p}^i\,(1 - \bar{p}^i)/n} \leq p^i \leq \bar{p}^i + z\,(1 - {}^{a}/2)\sqrt{\bar{p}^i\,(1 - \bar{p}^i)/n}.$$

Where $\bar{p}^i$ is the proportion of the total observations of tracks/day in the $i$th habitat category, $a$ the level of statistical significance, and $n$ the sample size (i.e. the total number of tracks/day) (Neu *et al.* 1974).

If the expected value fell within the interval, it was concluded that the species was utilizing the habitat type in accordance with its availability. If the expected proportion fell above or below the interval, the species was considered to be exhibiting an avoidance of, or preference for, that habitat type, respectively. These data are presented as a comparison of the proportion of vegetation or terrain type and the proportional occurrence of observations per track-day for each species of furbearing animal.

### 3.3 Wolf Observational Data

Wolf observational data was compiled from various sources to supplement the data obtained from track-count surveys. Track-count

surveys usually provide an "all or nothing" picture of the wolf population based on tracks encountered during track-count surveys. This occurs because wolf densities are low in comparison to the smaller furbearers, most wolves travel in packs during winter and wolf home ranges and movements are extensive.

The following people or agencies, that were known to have conducted work in the Liard River region, were contacted to obtain their records of wolves observed:

L. Goulet, Wildlife Biologist, Environmental and Socio-Economic Services, B.C. Hydro and Power Authority, Vancouver.

R. Daloise, Conservation Officer, B.C. Fish and Wildlife Branch, Fort Nelson.

R. Puttonen, Trapper, Lower Liard Crossing.

B. Lincoln, Regional Wildlife Management Biologist, Okanagon Region, B.C. Fish and Wildlife Branch, Penticton.

J. Elliot, Regional Biologist, B.C. Fish and Wildlife Branch, Fort St. John.

B. Webster, Wildlife Technician, B.C. Fish and Wildlife Branch, Fort St. John.

S. Willett, Manager Omineca Peace Region, B.C. Fish and Wildlife Branch, Fort St. John.

R.L. and L. Environmental Services Ltd., Edmonton.

Wolf observations reported were compiled on a map of the study area showing the location of observations, date, and number of wolves observed.

## 3.4 Fur Harvest Statistics

Fur harvest records for the 1978-79 and 1979-80 trapping seasons were obtained through the cooperation of R. Daloise, Conservation Officer, Fort Nelson and G. Pearson, Conservation Officer, Cassiar, B.C. Fish and Wildlife Branch. Information on the provincial fur harvest during this period and average prices of each species of furbearing mammal were obtained from B. Saunders, Fur Biologist, B.C. Fish and Wildlife Branch, Victoria.

The fur harvest data were summarized to show the average annual fur harvest during the period 1973 to 1980 for reporting or active traplines and the value of this harvest at an average of the 1978-79 and 1979-80 fur prices. These years were selected to illustrate the approximate current value of the fur harvested in the study area. Fur harvest data were also summarized by trapping season to show the annual variation in furbearer harvest. This information is compared to the provincial fur harvest and used to assess the importance of the furbearer resource in the Liard River region. The locations of the twenty reporting trapping areas were obtained from B.C. Fish and Wildlife Branch (Fort Nelson and Cassiar) maps, transferred to 1:250,000 topographic maps and the size of each trapping area calculated by the use of a dot grid.

## 3.5 Impact Assessment

The objectives of the environmental impact assessment of the Liard River Hydroelectric Project are:

1. to predict the magnitude and duration of impacts (changes) to furbearers and their use that would result from the development, and

2. to provide recommendations to prevent or minimize adverse impacts and to optimize beneficial impacts.

The assessment of potential impacts on furbearing mammal populations and their use is based on the following information:

1. data on the occurrence, abundance and habitat use of furbearing mammals and the use of furbearers by the trapping industry,

2. knowledge of the ecology of natural populations of furbearing mammals and the effects of industrial developments on these populations, and

3. available descriptions of the development activities and environmental changes that will accompany the Liard River Hydroelectric Project. Descriptions of development were taken from the following reports.
   a) Liard River basin vegetation studies, Final Draft Report. Prepared by Techman Ltd. and Ceska Geobotanical Research Co. for British Columbia Hydro and Power Authority, September 1980. 75 p.

   b) Hydroelectric development of the Liard River, Section 4.2. Sediment Regime. Report No. 891 Hydroelectric Design Division, British Columbia Hydro and Power Authority. 1978. pages 4-4 and 4-5.

   c) Industrial Forest Service Ltd. 1979. Liard River forest resource and reservoir clearing study. Prepared for British Columbia Hydro and Power Authority.

d) Area Plan - Liard River Feasibility Study Program Report - 1978 work, Plate 2-1, excerpts from: British Columbia Hydro and Power Authority, 1978. Hydroelectric development of the Liard River.

e) Liard River Feasibility Study - Plate 3-1 (Scheme 2 - Project locations, reservoirs and area access) and Plate 9-4 (Site E Project - Alaska Highway relocation. British Columbia Hydro and Power Authority.

f) Personal communications with Dr. S.M. Hirst, Environmental Studies Coordinator, Environmental Resources Department, British Columbia Hydro and Power Authority.

### 3.5.1 Documentation of Potential Impacts

The documentation of potential impacts on furbearing mammal populations involves an understanding of project activities and wildlife populations that would be involved in interactions and an estimate of the magnitude and duration of the changes in the wildlife populations resulting from these interactions.

When industrial activities such as a hydroelectric development impinge upon an animal's habitat in a direct or indirect manner, there is an obvious potential for adverse and occasionally beneficial effects on the animal's population. However, the adverse effects may, in some cases, be reduced or avoided by appropriate mitigative actions. Industrial developments and activities must also comply with government acts, regulations and guidelines for environmental protection.

Therefore, the approach to the documentation of impacts involves the identification of project activities that may result in impacts and an assessment of the level and significance of those potential impacts on furbearing mammal populations. This process will identify those areas of major concern for which mitigative actions are required. When the recommended mitigative measures are incorporated into the development plans for the Liard River Hydroelectric Project, the residual or unavoidable adverse impacts can be documented and assessed.

The documentation of potential impacts on fur resource harvesting will be based on the predicted impacts of the development on populations of furbearing mammals and on the probable interactions of development activities with trapping operations.

3.5.1.1 Environmental Effects

The method used to assess the magnitude of impacts on furbearing mammal populations was to categorize the environmental effects of the project and estimate the change in numbers of animals from each effect. Environmental effects fall into three categories: habitat alteration, disturbance and direct mortality.

a) Habitat Alteration

Habitat alteration includes both habitat loss and habitat gain. Habitat loss occurs when a habitat is physically altered or otherwise made unavailable to an animal (because of barriers to use or intolerable disturbance) as a result of project activities. A habitat gain occurs when a habitat is altered or made more available such that its carrying capacity for a particular species of animal is increased. These changes affect animals indirectly and result in a reduction or increase in their populations in proportion to the amount and importance of the habitat alterations.

Habitat changes which are detrimental to some species may be beneficial to others because different species of wildlife are adapted to different vegetation succession stages, or different degrees of aquatic association.

In this assessment, the number of animals lost from the population will depend on the amount of habitat lost, the season and duration of loss and the numbers of animals normally using the areas prior to the habitat becoming unavailable.

b) Disturbance

Disturbance has a direct effect on wildlife through the animal's sensory perception and reaction to project activities. Continuous disturbances to which an animal may react by avoidance (i.e. the animal stays beyond the range within which the disturbance is intolerable) will result in habitat exclusion. Habitat exclusion is treated as habitat loss with the resulting reduction in the animal population being in proportion to the amount and importance of the habitat made unavailable because of continuous disturbances.

Discontinuous disturbances allow the animal to be within the range of periodic disturbance, and often result in stress, escape reactions, and concomitant increased energy expenditures. The effect of increased energy expenditure or reduced rate of energy gain may be manifested in increased mortality (starvation, predation, disease, etc.) or in the decreased production of young (decrease in pregnancy rates, increase in abortion or absorption of embryos). Fleeing from disturbances may also result in injuries and abandonment of young. Project activities that may result in disturbance to wildlife include: human presence, noise and motion of construction and operation equipment, and traffic.

c) Direct Mortality

Direct mortality of furbearing mammals could result from certain project activities. These may include: collision with vehicles on haul roads, ingestion of toxic materials at garbage dumps, increased hunting pressure induced by the project, destruction of problem animals (i.e. bears at garbage dumps or near construction camps), and loss of animals during vegetation clearing and flooding of the impoundment. While the number of animals likely to die as a result of project activities cannot be objectively estimated, experience with similar projects will provide some indication of probable impact. Although there exists little specific data documenting pre-project vs. post-project effects, it is logical to assume that the animal populations will be naturally reduced to the carrying capacity of the remaining habitat (Ortolano 1973). A good deal of related unpublished literature exists in the form of analyses of "probable effects" of proposed reservoir projects on wildlife. These analyses which are used and accepted by government agencies generally identify the habitats to be inundated and the corresponding species that would be destroyed or forced to relocate. The analyses typically forcast expected displacement and associated effects, such as migration to adjacent lands, gradual species die-off due to reduced reproduction caused by stress and malnutrition, destruction of non-mobile species, etc. (Ortolano 1973).

3.5.1.2 Level and Significance of Impacts

The level and significance of an impact are put in perspective by using the following criteria:

a) Magnitude of impact (high, moderate or low);
b) Duration of impact (short-term or long-term);
c) Nature of impact (reversible or irreversible); and
d) Value of impact (positive or negative).

a) Magnitude of Impact

The magnitude of impact, in the context of this report, is a subjective assessment based on the interpretation of project design, field data and published information. Certain project activities will affect animals directly (e.g. through disturbance or direct mortality) or indirectly (e.g. through habitat alteration) resulting in a reduction in population size. The magnitude of impact, using the relative scale of low, moderate or high, is therefore ranked by assessing both the degree of intensity of the potential impact and the area of habitat to be affected. An example of a low magnitude of impact would be that caused by discontinuous disturbances from survey activities or transmission line construction activities which would interact with many animals (i.e. large area affected) but result in the deaths of few individuals (low intensity impact). An example of a high magnitude of impact would be that caused by habitat loss from vegetation clearing and flooding of the impoundment (i.e. large area affected) and result in the displacement and mortality of a relatively high number of animals (high intensity of impact).

b) Duration of Impact

The duration of an impact is the period of time it takes for the population to recover from the change in numbers it experienced as a result of project activities. The duration of a change in animal numbers is usually expressed in years. In this assessment, the duration of impact is divided into short-term (effects lasting 1 to 5 years) and long-term (effects lasting longer than 5 years). This is used to distinguish among impacts that are limited to the preconstruction and construction phases (1 to 5 years) and those impacts that would last for the duration of the operation phase (i.e. the hydroelectric dam is

considered to be a permanent structure with life span in the order of thousands of years for Regions G and E and many hundreds of years for Region A (British Columbia Hydro and Power Authority 1978). Habitat destruction which requires vegetation succession to occur before animal populations can recover is also considered long-term.

c) Nature of Impact

The nature of impact in relation to the populations' ability to recover its former abundance is described as reversible or irreversible. Where the habitat is permanently changed (i.e. flooding of terrestrial and aquatic habitats) resulting in permanent losses to animal populations, the nature of impact is considered irreversible. Where terrestrial or aquatic habitats have been altered and subsequently reclaimed and allowed to revert to natural vegetation cover, or only a small portion of the population is adversely affected and thus has the capability of recovering its former numbers through recruitment, the impact is considered reversible.

d) Value of Impact

The value of impact is described as positive or negative where an increase or decrease, respectively, occurs in wildlife habitat and/or wildlife populations.

# 4.0 RESULTS AND DISCUSSION

## 4.1 Winter Track-count Surveys

Track-count surveys were conducted during nine days of suitable snow conditions between December 2 and 17, 1980. A total of 144.2 km of transects were covered on 22 transect lines representing a sample size of 447.3 km-days. The location and distribution of transect lines are shown in Figure 2.

Survey conditions during track-count surveys were variable in relation to survey times and region. Surveys in the areas between the Deer River and Site A during December 3 to 6, 1980, were conducted with relatively shallow snow depths (ranging from 10 to 30 cm) and extremely low temperatures (highs of -30° to -45° during the daylight period). While the low temperatures may have reduced the activities of the smaller furbearers such as ermine, mink or red squirrels, the shallow snow provided little subnivean habitat, forcing these animals to travel across the snow surface, thus insuring a more accurate record of these animals activities. Surveys in the areas between Trout River and Kechika River were conducted under relatively mild temperatures (-20° to -5°) and moderate snow depths (a range of 20 cm to 50 cm).

Seven of the fourteen species of furbearing mammals known to occur in the study area were recorded along transect lines (Table 2). The data include the snowshoe hare to exemplify the relative abundance of the different species and as a relative measure of importance as prey species. Fisher, wolverine, river otter, red fox and lynx were not recorded along transect lines. Three species of furbearing mammals not included in Table 2 are weasel (combined with ermine) beaver and muskrat. Other species recorded on during field studies were moose (*Alces alces*) and porcupine (*Erethizon dorsatum*).

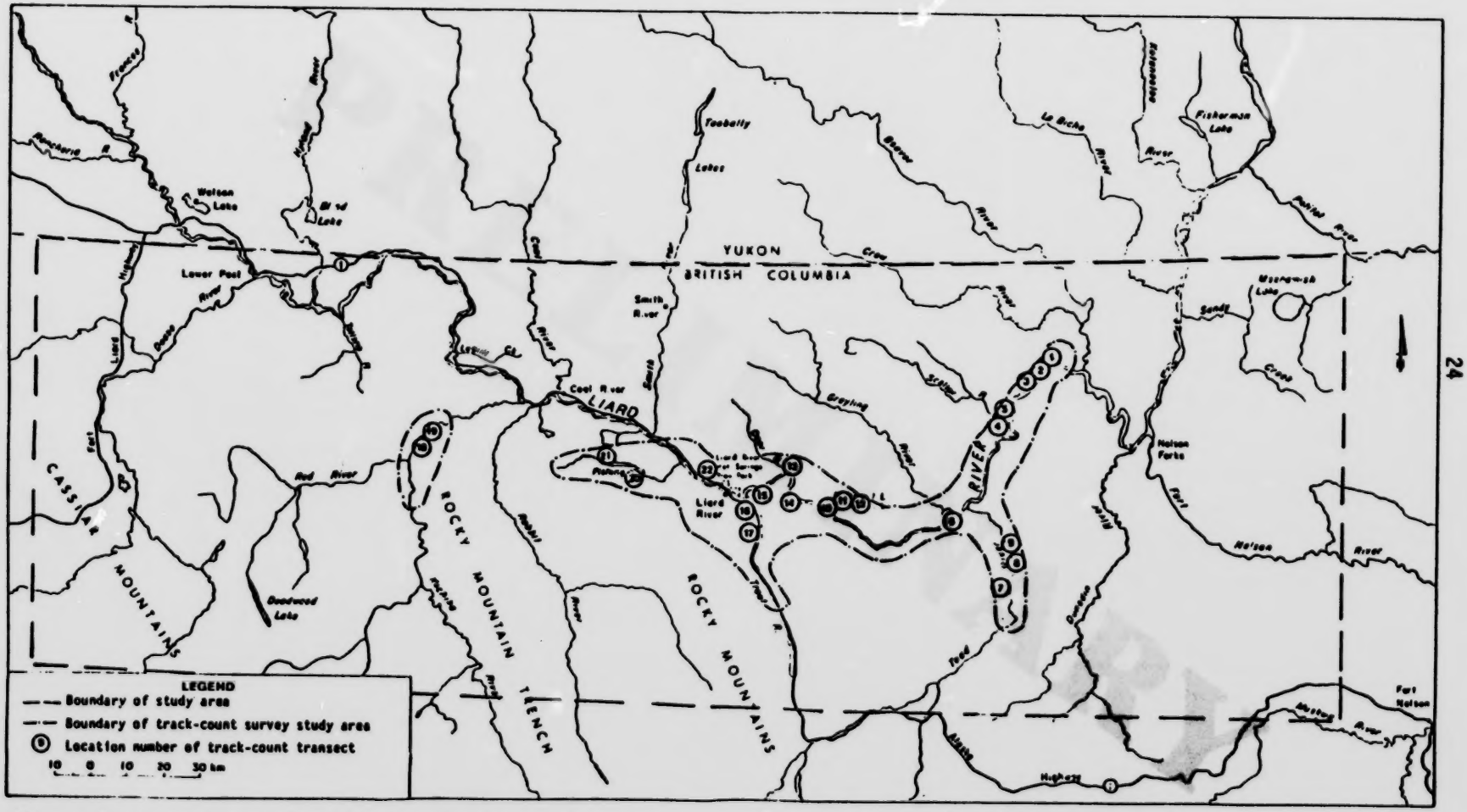


Figure 2. Location of the 1980 winter furbearer track-count transects in the Liard River study area, British Columbia.

Table 2. Relative abundance indices (tracks per km-day) of furbearers within the Liard River study area during 1979 and 1980 studies and other studies in the boreal forest region.

| LOCATION | Ermine | Mink | Marten | Fisher | Wolverine | River Otter | Red Fox | Coyote | Wolf | Lynx | Red Squirrel | Snowshoe Hare | Kilometre-Days | BOREAL FOREST SECTION[j] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Liard River 1980 This Study | 2.05 | 0.15 | 2.79 | | | | | 0.01 | 0.03 | | 2.63 | 7.72 | 447 | Upper Liard |
| Liard River[a] 1979 | 0.22 | 0.02 | 0.79 | 0.01 | | 0.01 | 0.01 | | | 0.37 | 1.88 | 21.48 | 471 | Upper Liard |
| Monkman Coal Mine[b] 1980 | 0.94 | 1.14 | 1.69 | | 0.02 | | 0.01 | 0.11 | 0.04 | * | 1.74 | 36.21 | 301 | Upper Foothills |
| McGregor River[c] 1977 | 1.17 | 0.14 | 0.86 | 0.05 | 0.08 | 0.03 | 0.06 | 0.08 | 0.03 | | 1.63 | 0.01 | 130 | Interior Subalpine |
| Chick Lake[d] Fall 1974 | 0.54 | 0.11 | 4.08 | | * | | 0.34 | * | * | 0.03 | 1.59 | 2.36 | 196 | Northwestern Transition |
| Chick Lake[e] Spring 1973 | 0.18 | * | 0.94 | | 0.01 | | 0.01 | 0.03 | 0.03 | 0.07 | n/a | n/a | n/a | Northwestern Transition |
| Moon Lake[d] Fall 1974 | 0.13 | 0.01 | 3.78 | | 0.01 | | * | * | * | * | 0.02 | 3.20 | 271 | Northwestern Transition |
| Moon Lake[e] Spring 1973 | 0.09 | 0.01 | 1.29 | | * | | * | * | * | 0.03 | n/a | n/a | n/a | Northwestern Transition |
| Bistcho Lake[f] 1973 | 0.72 | * | 0.11 | | | | 0.04 | | | 0.01 | 0.11 | 0.46 | 140 | Hay River |
| Hotchkiss River[f] 1973 | 0.94 | 0.01 | 0.09 | 0.08 | 0.01 | | 0.03 | 0.03 | 0.38 | 0.61 | 1.01 | | 159 | Lower Foothills |
| Peace River[g] 1974 | 2.00 | * | 0.06 | * | * | | 0.06 | 0.63 | * | 0.06 | 2.94 | 2.81 | 84 | Mixedwood Forest |
| Fort McMurray[h] 1976 | 1.47 | 0.11 | 0.06 | | 0.01 | | 0.02 | 0.29 | 0.07 | * | 2.33 | 2.94 | 1346 | Mixedwood Forest |
| Ft. Simpson[i] 1975 | 0.25 | | 0.47 | | * | | | * | * | * | 0.10 | 0.18 | 524 | Upper Mackenzie |

[a] Penner (1979).
[b] Penner (1980).
[c] Penner (1977).
[d] Douglass, Fisher and Mair (1976).
[e] Douglass and Wooley (1974).
[f] Wooley (1974a and 1974b).
[g] Penner (1975).
[h] Penner (1976).
[i] Wooley and Wooley (in press).
[j] Rowe (1972).
* Relative abundance in less than 0.01
n/a data not available.

### 4.1.1 Relative Abundance of Furbearing Mammals

Snowshoe hare, marten, red squirrel and ermine were the common mammals recorded during the survey; the mean density of tracks were 7.72, 2.79, 2.63 and 2.05 tracks per km-day, respectively (Table 2). Mink were moderately abundant with an average track density of 0.15 tracks per km-day. Coyote and wolf were the least abundant species recorded (0.01 and 0.03 tracks per km-day, respectively). Furbearers known to occur in the region but not recorded during the track-count survey were: fisher, wolverine, river otter, red fox and lynx. Sign of beaver (lodges, dams and cuttings) and muskrat (houses) were observed during field studies. Observations are not included in this report as better methods using systematic surveys of food cache and house counts are available to census these populations.

Table 2 compares the relative abundance of furbearers recorded by track-count surveys during the 1980 studies with those obtained on the western portions of the Liard River during the 1979 studies and the studies in other regions of the boreal forest. Snowshoe hare track-densities in 1980 were lower than those found in the Liard River drainage during 1979. This may relate to a recent decline in the abundance of this species or differences in habitat sampled during the two years of study. The abundance of snowshoe hares are still higher than those found in most other studies in the Boreal Forest Region. The relative abundance of red squirrel, ermine, mink and marten observed during the 1980 surveys were all higher than those observed during the 1979 studies in the Liard River valley and generally among the highest indices of these species recorded in other studies in the Boreal Forest Region. Coyote and wolf tracks were not recorded during the 1979 studies and occurred in relatively low abundance during the 1980 track-count survey.

### 4.1.2 Regional Abundance of Furbearing Mammals

The abundance indices of common furbearing mammals are compared among six areas examined during the 1980 track-count survey (Appendix 1). The observed differences in animal abundance are generally related to animal habitat preferences and the different proportions of various vegetation, terrain and wetland types sampled in each area. Marten are locally common in the Trout and Deer river, Liard Hot Springs, Fishing Lake, and Toad and Grayling river areas while mink appear locally common in the Norquist-Aline lakes and Toad and Grayling river areas.

General trends in regional abundance of different furbearers shown by fur harvest returns are discussed in Section 4.2.2.

### 4.1.3 Distribution of Furbearing Mammals in relation to Physical Features

#### 4.1.3.1 Distribution in Relation to Vegetation Types

The relative abundance of furbearers in different vegetation types is shown as an index of tracks per km-day (Table 3). These data allow comparison of the relative abundance of various furbearers within a particular vegetation type. Lodgepole pine and mixed spruce-pine forest types are included in this table although the availability of this habitat is limited in the region sampled during 1980. These types are hereafter combined with the coniferous mixedwood forest vegetation type to facilitate statistical evaluation of habitat selection.

Table 4 compares the availability of vegetation types (based on the proportion of transect lines surveyed) and the use of vegetation types by furbearers as determined by the winter track-count survey. Ermine, marten, red squirrel and snowshoe hare distribution showed a

Table 3. Relative abundance (tracks/km-day) of terrestrial furbearers in various vegetation types during track-count surveys December 2 to 17, 1980.

| Vegetation Type | Distance along transects (km) | Ermine | Mink | Marten | Coyote | Wolf | Red Squirrel | Snowshoe Hare |
|---|---|---|---|---|---|---|---|---|
| Spruce forest | 15.71 | 1.71 | 0.14 | 4.56 | 0 | 0.02 | 6.90 | 13.12 |
| Lodgepole pine forest | 0.60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Black spruce wetland forest | 6.92 | 0.19 | 0.26 | 0.82 | 0 | 0 | 2.16 | 4.57 |
| Mixed spruce-pine forest | 0.29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Coniferous mixedwood forest | 18.11 | 2.26 | 0.06 | 3.27 | 0 | 0 | 4.51 | 5.50 |
| Deciduous mixedwood forest | 4.51 | 4.88 | 0.06 | 2.18 | 0 | 0 | 1.86 | 0 |
| Deciduous forest | 2.06 | 0 | 0 | 1.70 | 0 | 0 | 0 | 0.12 |
| Burn with lodgepole pine | 9.15 | 2.19 | 0 | 1.20 | 0 | 0 | 0.77 | 30.09 |
| Burn with deciduous shrubs | 22.36 | 4.27 | 0.48 | 4.32 | 0 | 0.09 | 0.10 | 7.23 |
| Burn with herbaceous cover | 1.46 | 0.36 | 0 | 3.42 | 0 | 0 | 0 | 0 |
| Floodplain deciduous forest | 5.46 | 0.30 | 0.07 | 0.61 | 0 | 0 | 1.11 | 5.50 |
| Floodplain mixedwood forest | 18.08 | 0.89 | 0.07 | 2.79 | 0 | 0.12 | 3.09 | 6.33 |
| Floodplain white spruce-alpine fir forest | 24.25 | 1.51 | 0.04 | 2.01 | 0 | 0 | 3.85 | 5.59 |
| Riparian tall shrub-grassland | 7.90 | 3.04 | 0.44 | 3.80 | 0.13 | 0 | 0.11 | 3.42 |
| Herbaceous and low shrub | 0.79 | 3.48 | 0.32 | 1.89 | 0 | 0 | 0 | 0 |
| No cover-wetland | 5.24 | 1.15 | 0 | 0.54 | 0 | 0.04 | 0 | 0.04 |
| No cover-disturbance | 1.33 | 0.25 | 0 | 2.15 | 0 | 0 | 0 | 4.51 |
| TOTAL | 144.22 | | | | | | | |
| Average Tracks/km-day | | 2.05 | 0.15 | 2.79 | 0.01 | 0.03 | 2.63 | 7.72 |

Table 4. Relative use of vegetation types by furbearing mammals, December 1980.

| Vegetation Type | Composition[a] | Percentage of Total Observations of each species (tracks/day) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Ermine | Mink | Marten | Coyote | Wolf | Red Squirrel | Snowshoe Hare |
| Spruce forest[d] | 10.9 | 8.9 o[b] | 9.5 | 18.9 + | | 7.0 | 29.2 + | 17.8 + |
| Black spruce-wetland forest | 4.8 | 0.1 - | 8.2 | 1.5 - | | | 3.5 - | 3.0 - |
| Coniferous mixedwood forest | 13.2 | 12.6 o | 4.5 | 14.6 o | | | 20.6 + | 8.9 - |
| Deciduous mixedwood forest | 3.1 | 7.6 + | 1.4 | 2.4 o | | | 2.2 o | |
| Deciduous forest | 1.4 | | | 0.9 o | | | | 0.1 - |
| Burn with lodgepole pine | 6.3 | 6.9 o | | 2.7 - | | | 1.9 - | 24.7 + |
| Burn with deciduous shrubs | 15.6 | 32.9 + | 46.8 | 24.3 + | | 44.4 | 0.6 - | 14.5 o |
| Burn with herbaceous cover | 1.0 | 0.7 o | | 1.2 o | | | | |
| Floodplain deciduous forest | 3.8 | 0.6 - | 1.8 | 0.8 - | | | 1.6 - | 2.7 o |
| Floodplain mixedwood forest | 12.5 | 5.8 - | 5.9 | 11.4 o | | 44.4 | 15.2 o | 12.6 o |
| Floodplain spruce - fir forest | 16.9 | 12.6 - | 4.5 | 12.0 - | | | 24.9 + | 12.2 - |
| Riparian tall shrub-grassland | 5.5 | 8.3 o | 15.9 | 7.4 o | 100.0 | | 0.2 - | 2.4 - |
| Herbaceous and low shrub | 0.5 | 1.0 o | 1.4 | 1.1 o | | | | |
| No cover - wetland | 3.6 | 2.1 o | | 0.5 - | | 4.4 | | 0.1 - |
| No cover - disturbance | 0.9 | 0.1 - | | 0.2 - | | | | 0.5 o |
| Total observations (track/day) | | 290.4 | 22.0 | 404.8 | 1.0 | 4.5 | 375.0 | 1127.8 |
| Statistical significance Chi-square calculated: Tabular value P<0.05=23.7 | | 119.8*[c] | d | 89.5* | d | d | 264.5* | 825.3* |

[a] Proportion of tracking transects.

[b] "+" indicates that the proportion of observations is significantly greater than the proportion of vegetation type available in the study area, "-" significantly less and "o" not significantly different.

[c] * significant difference at P=0.05; n.s. not significantly different; d=sample size insufficent for testing.

[d] combines white spruce and white spruce - black spruce forest.

significant difference from the availability of vegetation types. The sample size of tracks for mink, coyote and wolf was insufficient for testing (Appendix 2).

For those species whose distribution showed a significant difference from the availability of vegetation types, confidence intervals were calculated on the observed use to detect preference or avoidance of each vegetation type (Table 4). For example, ermine use of burn, with deciduous shrubs, and deciduous mixedwood forest was significantly greater than expected while black-spruce wetland, floodplain deciduous, mixedwood and spruce-fir forests and no cover, due to disturbance, was used significantly less than expected according to the availability of those vegetation types. Vegetation types in which no tracks were recorded were also considered to be avoided by ermine. Other vegetation types were used in approximate proportion to their availability and were considered to be neither preferred nor avoided by the furbearing mammal.

The distribution of furbearers in relation to vegetation types is discussed in more detail in Section 4.3.

4.1.3.2 Distribution in Relation to Terrain

Table 5 compares the availability of terrain features and use by furbearers as determined by track-counts. Ermine, marten, red squirrel and snowshoe hare distributions were significantly different while mink was not significantly different from the availability of terrain types. The sample size of tracks for coyote and wolf were insufficient for testing (Appendix 3).

The distribution of furbearers in relation to terrain are discussed in more detail in Section 4.3.

Table 5. Relative use of terrain types by furbearing mammals, December 1980.

| Terrain Feature | Proportion of Tracking Transect | Percent of Observations (tracks/day) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Ermine | Mink | Marten | Coyote | Wolf | Red Squirrel | Snowshoe Hare |
| Wetlands | 27.7 | 17.2 - | 37.7 | 15.4 - | | 4.4 | 5.8 -[a] | 5.7 - |
| Valley bottom - alluvial | 25.7 | 15.2 - | 25.1 | 19.6 - | 100.0 | 22.1 | 29.4 o | 28.7 + |
| 0 - 10% slope (flat to undulating | 36.5 | 59.2 + | 37.1 | 33.2 o | | 73.5 | 35.6 o | 58.4 + |
| 10 to 30% slope | 7.5 | 3.9 - | | 18.6 + | | | 22.4 + | 3.5 - |
| 30 - 60% slope | 1.5 | 4.6 + | | 11.8 + | | | 6.8 + | 2.8 + |
| 60+% slope | 1.1 | | | 1.3 o | | | | 0.8 o |
| Total observations (tracks/day) | | 290.4 | 22.0 | 404.8 | 1.0 | 4.5 | 375.0 | 1127.8 |
| Statistical significance Chi- square calculated (Appendix 3): Tabular value P<0.05=11.1 | | 91.9[b] | 3.0[n.s.] | 391.8* | d | d | 254.2* | 388.8 |

[a] "+" indicates that the proportion of observations is significantly greater than the proportion of vegetation type available in the study area, "-" significantly less and "o" not significantly different.

[b] significantly different at P=0.05; n.s. not significantly different and d=sample size insufficent for testing.

#### 4.1.3.3 Distribution in Relation to Wetlands

Table 6 compares the availability of wetland types and shoreline types with use by furbearers as determined by track-counts. These data were gathered to specifically examine semi-aquatic furbearer (mink and river otter) habitat use. Mink distributions were not significantly different from the availability of wetland or shoreline habitat types. River otter were not recorded during the 1980 studies.

## 4.2 Trapping and Fur Harvest

Twenty-eight registered trapping areas were identified in the region examined for fur harvest returns. Additional unidentified trapping areas are found on the periphery of the region examined or were not registered trapping areas.

Fur harvest returns were compiled from twenty registered traplines that had reported a harvest of furbearing mammals. The fur harvest returns from all reporting trappers' are used in this report to document the occurrence of furbearing mammal populations in the region and to document the average and range of animals harvested and their monetary value to trappers. However only some of the reporting trapping areas are included in the thirteen trapping areas that would be directly affected by the proposed hydroelectric development.

The twenty registered trapping areas that submitted fur harvest returns are mainly held by non-Indian trappers. Four trapping areas registered to native Indians were also identified in the study area. The status of another four additional trapping areas are unknown. Indian trappers are not required to obtain trapping licences or submit fur harvest returns. Penner (1979) provides an estimate of the extent of the fur harvested on Indian traplines from extrapolation of a study

Table 6. Relative use of wetland and shoreline types by furbearing mammals, December 1980.

| WETLAND TYPES | | | Percentage of Total Observations per Track-day | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wetland Type | Transect Distance (km) | Proportion of Transects | Ermine | Mink | Marten | Wolf | Red Squirrel | Snowshoe Hare |
| F1 | 3.15 | 6.4 | 1.9 | 6.2 | 5.8 | 0 | 13.6 | 0 |
| F2 | 8.46 | 17.1 | 12.0 | 8.6 | 26.4 | 100.0 | 0.6 | 10.5 |
| F3 | 12.05 | 24.4 | 35.3 | 10.7 | 2.5 | 0 | 27.0 | 12.3 |
| F4 | 8.69 | 17.6 | 13.0 | 10.7 | 15.0 | 0 | 27.9 | 23.7 |
| F5 | 6.11 | 12.4 | 20.8 | 27.9 | 36.3 | 0 | 0 | 38.9 |
| F6 | 10.96 | 22.2 | 17.3 | 35.8 | 14.0 | 0 | 30.9 | 14.7 |
| TOTAL | 49.42 | 100.1 | 100.3 | 99.9 | 100.0 | 100.0 | 100.0 | 100.1 |
| Total Observation per track-day | | | 38.6 | 11.6 | 88.8 | 0.5 | 38.8 | 112.2 |
| Statistical significance Chi-square Tabular Value P<0.05=11.1 | | | $6.72^{n.s.}$ | $4.92^{n.s.}$ | $65.65^{*}$ | d | $17.83^{*}$ | $84.76^{*}$ |

| SHORELINE TYPES | | | Percentage of Total Observations per Track-day | | | | | |
|---|---|---|---|---|---|---|---|---|
| Shoreline Type | Transect Distance (km) | Proportion of Transects | Ermine | Mink | Marten | Wolf | Red Squirrel | Snowshoe Hare |
| Cutbank | 17.29 | 35.0 | 24.5 | 32.2 | 42.5 | 0 | 15.5 | 51.4 |
| Steep slopes | 9.50 | 19.2 | 35.7 | 16.3 | 9.3 | 0 | 39.2 | 6.9 |
| Gravel bars | 5.87 | 11.9 | 9.7 | 8.6 | 22.8 | 100.0 | 0.6 | 3.1 |
| Treed | 12.32 | 24.9 | 25.0 | 40.0 | 20.0 | 0 | 24.5 | 37.3 |
| Marsh margin | 4.44 | 9.0 | 5.2 | 2.8 | 5.4 | 0 | 20.3 | 1.2 |
| TOTAL | 49.42 | 100.0 | 100.1 | 99.9 | 100.0 | 100.0 | 100.1 | 99.9 |
| Total Observation per track-day | | | 38.6 | 11.6 | 88.8 | 0.5 | 38.8 | 112.2 |
| Statistical significance Chi-square Tabular value P<0.05=9.49 | | | $7.45^{n.s.}$ | $1.72^{n.s.}$ | $13.20^{*}$ | d | $22.22^{*}$ | $39.3^{*}$ |

[a] * significantly different at P=0.05; n.s. not significantly different and d=sample size insufficient for testing.

by Ward (1979) and from personal communications with R. Daloise and B. Bailey (District Conservation Officers, B.C. Fish and Wildlife, Fort Nelson and Cassiar, respectively). Former trapline TL20 has been withdrawn as a registered trapline and redesignated as a District Line where residents around Lower Post can trap under permit. The local school system and G. Pearson (District Conservation Officer, Cassiar) have established a trapper training program to teach students the proper methods used in trapping (G. Pearson, pers. comm.). An unspecified number of furs were harvested from this trapping area during the 1979-1980 season.

The locations of registered trapping areas and the areas for which fur harvest data were obtained are shown in Figure 3. The names of the trappers on these lines have been submitted separately from this report to B.C. Hydro and Power Authority to protect the confidentiality of individual trapper's fur harvest returns.

4.2.1 Fur Harvest on Reporting Traplines

The furbearing mammals harvested in greatest numbers in the Liard River drainage are marten and red squirrel (Table 7). Beaver, muskrat and lynx were harvested in moderate numbers. Based on the average annual harvest per trapping area, relatively low numbers of the other furbearers were harvested.

The mean annual fur harvest is calculated for the number of years that each trapline has reported animals caught during the period between 1973 and 1980. Fur harvest returns represent an average of 3.6 years of harvest records per trapline (a range of 1 to 7 years) (Table 7).

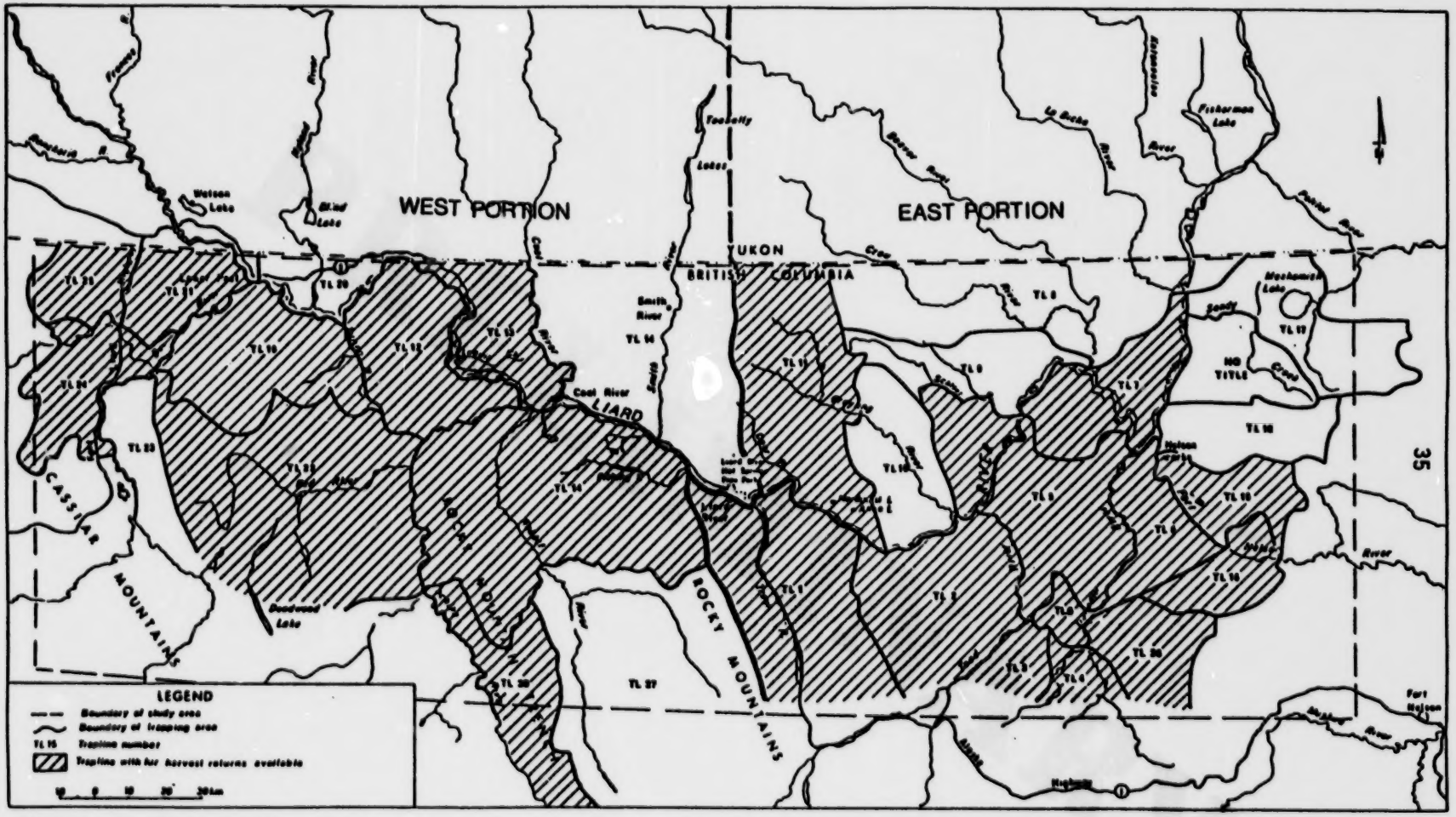


Figure 3. Distribution of registered trapping areas in the Liard River drainage, British Columbia.

Table 7. Mean annual fur harvest from registered traplines in East and West Portions of the Liard River drainage, British Columbia, during trapping seasons 1973-74 to 1979-80.

| FURBEARER | East Region Traplines[a] | | | | | | | | | | | All East Portion Traplines | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TL1 | TL2 | TL3 | TL4 | TL5 | TL6 | TL7 | TL11 | TL15 | TL16 | TL26 | Total | Mean[f] |
| Beaver | 2.0[d] | 0.7 | 0 | 14.0 | 10.7 | 1.5 | 69.0 | 21.7 | 75.0 | 37.5 | 24.0 | 256.1 | 14.4 |
| Muskrat | 0 | 0 | 0 | 1.0 | 2.0 | 0 | 11.0 | 15.3 | 25.0 | 0 | 0 | 54.3 | 3.0 |
| Red Squirrel | 50.2 | 47.8 | 16.0 | 33.2 | 147.1 | 7.5 | 1049.0 | 19.2 | 60.0 | 12.0 | 31.0 | 1473.0 | 66.1 |
| Ermine | 1.7 | 3.7 | 0.3 | 3.5 | 6.3 | 2.2 | 4.0 | 1.7 | 30.0 | 0.8 | 0 | 54.2 | 3.3 |
| Mink | 0.3 | 0 | 0 | 1.7 | 1.3 | 1.7 | 5.0 | 3.0 | 0 | 1.2 | 1.0 | 15.2 | 1.3 |
| Marten | 41.2 | 26.7 | 1.7 | 73.7 | 87.4 | 35.5 | 86.0 | 129.3 | 160.0 | 32.2 | 64.0 | 737.7 | 60.4 |
| Fisher | 0 | 0.7 | 0 | 0 | 0.1 | 0 | 0 | 0 | 1.0 | 0.3 | 0 | 1.6 | 0.1 |
| Wolverine | 0 | 2.5 | 0.7 | 1.3 | 0.6 | 0.8 | 0 | 0.5 | 4.0 | 0.2 | 0 | 10.6 | 0.9 |
| River otter | 0 | 0 | 0 | 0.3 | 0.1 | 0 | 0 | 1.2 | 2.0 | 0.3 | 0 | 4.0 | 0.3 |
| Lynx | 1.2 | 5.7 | 0.7 | 4.7 | 1.7 | 0.8 | 0 | 6.3 | 10.0 | 2.5 | 0 | 33.6 | 3.1 |
| Red Fox | 1.7 | 0.3 | 0 | 0.3 | 0 | 0 | 0 | 1.2 | 0 | 0 | 0 | 3.5 | 0.3 |
| Coyote | 0.5 | 1.7 | 0.3 | 1.2 | 0 | 0 | 0 | 0.3 | 0 | 0.3 | 0 | 4.3 | 0.5 |
| Wolf | 2.5 | 0.2 | 3.0 | 3.0 | 0.9 | 0.3 | 0 | 1.5 | 3.0 | 0.8 | 2.0 | 17.2 | 1.4 |
| Number of reporting years | 6 | 6 | 3 | 6 | 7 | 6 | 1 | 6 | 1 | 6 | 1 | 49 | |

| FURBEARER | West Region Traplines | | | | | | | | | All West Portion Traplines | | All Traplines | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TL12[a] | TL13[ab] | TL14[a] | TL19[c] | TL21[c] | TL22[c] | TL24[c] | TL25[c] | TL28[c] | Total | Mean[f] | Total | Mean[f] |
| Beaver | 3.3[d] | 1.3 | 50.0 | 24.0 | 20.3 | 17.0 | 19.0 | 18.7 | 16.0 | 169.6 | 16.3 | 425.7 | 15.1 |
| Muskrat | 0.3 | 1.3 | 14.5 | 2.0 | 7.5 | 4.0 | 14.0 | 12.0 | 0 | 55.6 | 6.6 | 109.9 | 4.0 |
| Red Squirrel | 39.8 | 2.0 | 250.0 | 20.0 | 0 | 0 | 0 | 0 | 17.0 | 328.8 | 30.5 | 1,801.8 | 45.1 |
| Ermine | 1.8 | 1.0 | 1.0 | 0 | 0.3 | 0 | 0 | 0 | 0 | 4.1 | 0.6 | 58.3 | 2.4 |
| Mink | 2.3 | 3.0 | 5.0 | 4.0 | 6.3 | 6.3 | 5.0 | 6.7 | 0 | 38.6 | 4.6 | 53.8 | 2.3 |
| Marten | 16.8 | 47.7 | 30.5 | 40.0 | 33.0 | 17.3 | 28.0 | 43.3 | 9.8 | 266.4 | 30.1 | 1,004.1 | 50.7 |
| Fisher | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.6 | 0.1 |
| Wolverine | 0.8 | 0.7 | 0 | 1.0 | 0.3 | 0 | 0 | 0 | 0 | 2.8 | 0.3 | 13.4 | 0.7 |
| River otter | 0 | 0 | 1.5 | 0 | 0 | 0 | 0 | 0 | 2.8 | 3.5 | 0.2 | 7.4 | 0.3 |
| Lynx | 6.0 | 11.0 | 1.5 | 10.0 | 4.8 | 8.3 | 3.0 | 12.7 | 0 | 57.3 | 6.8 | 90.9 | 4.3 |
| Red Fox | 0.8 | 0.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.1 | 0.2 | 4.6 | 0.3 |
| Coyote | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4.3 | 0.4 |
| Wolf | 0.8 | 0.7 | 0 | 0 | 2.5 | 2.0 | 2.0 | 11.0 | 0 | 19.0 | 2.52 | 36.1 | 1.8 |
| Number of reporting years | 4 | 3 | 2 | 1 | 4 | 3 | 2 | 3 | 1 | 23 | | 72 | |

[a] Data from R. Daloise, Conservation Officer, B.C. Fish and Wildlife Branch, Fort Nelson.

[b] Data from Schultz, 1976.

[c] Data from B. Bailey and G. Pearson, Conservation Officers, B.C. Fish and Wildlife Branch, Cassiar.

[d] Number of pelts.

[e] One Black Bear taken in 1978-79.

[f] Weighted mean based on total harvest in all years divided by total active traplines during these years.

The fur harvest data should be interpreted with caution because of a low sample size (number of reporting years on some traplines) and the many variables which may influence the fur harvest in a particular region or year. These influencing variables include: the local abundance of furbearers and population cycles, individual trapper skill and effort, trapping methods, local weather conditions, the price of fur, and local socio-economic conditions, including opportunities for other forms of employment and income.

### 4.2.2 Fur Harvest in Eastern and Western Portions of the Study Area

Table 7 provides a comparison of the mean annual fur harvest on traplines in eastern and western portions of the Liard River drainage. The trends shown by fur harvest data for the East portion are generally applicable to evaluation of impact from dam alternative Site A and part of Site E. The trends shown by fur harvest data for the West portion is generally applicable to dam alternative Sites G, F, E and J.

Of the three most important fur species, the average annual harvest of lynx and beaver was higher on the West portion traplines whereas marten was higher in the East portion traplines. Mink, muskrat and wolves were also harvested in larger numbers in the West portion traplines whereas red squirrel and ermine were harvested in higher numbers in the East portion traplines. Low numbers of coyote and fisher were harvested only in the East portion traplines. While these data indicate trends in regional abundance of different species of furbearing mammamls, these comparisons should be interpreted with caution due to the many variables which may influence the fur harvest on a particular trapline or region and that annual returns from some traplines are only from a few years. Trends in regional abundance of different species of furbearers probably reflect the differences in habitat available in the East and West portions of the study area.

### 4.2.3 Value of Fur Harvest

The total annual income from twenty reporting traplines in the Liard River drainage was $90,790.15 (Table 8). Themean income per trapline was $4,539.51 (Table 8). This estimate is based on the average fur prices in British Columbia during the 1978-1979 and 1979-1980 seasons (Appendix 4). The range in average annual income is $814.33 to $12,844.49 (Table 9). The median average income of twenty trappers was $4,032.14.

The average income on traplines in the East portion ($4,827.30 was slightly higher than from traplines in the West portion ($4,187.75) (Table 8). The median average income was $3,519.85 and $4,208.58 for the East and West portions, respectively (Table 9).

Marten and lynx were the more important furbearers, contributing an average of 36.4 percent and 29.8 percent of average annual trapping income (Table 8). Lynx was the highest contributor (45.3%) to trappers' average annual income in the West portion traplines (Table 9). Marten contributed the highest average annual income (45.7%) to trappers in the East portion traplines. Marten and lynx were the second highest contributors (23.3% and 18.9%) to trappers in West and East portion traplines, respectively. Beaver and wolf made up the bulk of the remaining trapper income (an average of 17.7% and 5.0%, respectively). The remaining species of furbearing mammals contributed 11.1 percent of the average trapping income in the study area. With the exception of lynx, marten and red squirrel, the general trend of relative importance of different furbearing mammals to trappers' income was similar among traplines in the East and West portions. Red Squirrels were harvested in greater numbers in the East portion traplines where they contributed 5.6% of the trappers' income.

Table 8. Summary of fur harvest value[a] and average annual income on twenty reporting traplines in the Liard River drainage, British Columbia.

| Furbearer | Fur Harvest Value | | | Proportion of total value |
|---|---|---|---|---|
| | East Portion (14 traplines) | West Portion (9 traplines) | Total (20 traplines) | |
| Beaver | $ 9,655.26 | $ 6,391.85 | $16,047.11 | 17.7 |
| Muskrat | 331.41 | 339.04 | 670.45 | 0.7 |
| Red Squirrel | 2,975.41 | 664.08 | 3,639.49 | 4.0 |
| Ermine | 115.83 | 8.57 | 124.40 | 0.1 |
| Mink | 471.60 | 1,200.04 | 1,671.65 | 1.8 |
| Marten | 24,260.00 | 8,759.60 | 33,019.60 | 36.4 |
| Fisher | 261.24 | 0 | 261.24 | 0.3 |
| Wolverine | 1,936.42 | 489.14 | 2,425.56 | 2.7 |
| River otter | 320.46 | 282.52 | 602.98 | 0.7 |
| Lynx | 10,007.68 | 17,075.96 | 27,083.64 | 29.8 |
| Red fox | 273.32 | 84.34 | 357.66 | 0.4 |
| Coyote | 315.92 | 0 | 315.92 | 0.4 |
| Wolf | 2,175.74 | 2,394.71 | 4,570.45 | 5.0 |
| Total | $53,100.30 | $37,689.85 | $90,790.15 | 100.0 |
| Average per trapline | $4,827.30 | $4,187.75 | $4,539.51 | |

[a] Based on the average annual fur harvest per trapline (Table 9) and the average of the 1978-79 and 1979-80 fur prices (Appendix 4).

Table 9. Average annual income (based on average of 1978-79 and 1979-80 fur prices) from the harvest[a] on reporting traplines in the East and West portions of the Liard River drainage, British Columbia.

| FURBEARER | Traplines in the East Portion | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TL1 | TL2 | TL3 | TL4 | TL5 | TL6 | TL7 | TL11 | TL15 | TL16 | TL26 | Total East Portion traplines | Percent of East Portion |
| Beaver | $ 75.42 | $ 24.88 | $ 0 | $ 527.94 | $ 403.87 | $ 56.56 | $2,601.99 | $ 817.18 | $ 2,828.25 | $1,414.13 | $ 905.04 | $ 9,655.26 | 18.2 |
| Muskrat | 0 | 0 | 0 | 6.10 | 12.20 | 0 | 67.10 | 93.51 | 152.50 | 0 | 0 | 331.41 | 0.6 |
| Red Squirrel | 101.34 | 96.62 | 32.32 | 67.00 | 297.22 | 15.15 | 2,118.98 | 38.72 | 121.20 | 24.24 | 62.62 | 2,975.41 | 5.6 |
| Ermine | 3.57 | 7.85 | 0.71 | 7.49 | 13.46 | 4.64 | 8.56 | 3.57 | 64.20 | 1.78 | 0 | 115.83 | 0.2 |
| Mink | 10.29 | 0 | 0 | 52.05 | 40.21 | 52.05 | 155.85 | 93.51 | 0 | 36.47 | 31.17 | 471.60 | 0.9 |
| Marten | 1,354.08 | 877.18 | 54.93 | 2,423.01 | 2,875.57 | 1,167.60 | 2,828.54 | 4,253.66 | 5,262.40 | 1,058.07 | 2,104.96 | 24,260.00 | 45.7 |
| Fisher | 0 | 27.08 | 0 | 0 | 22.30 | 0 | 0 | 0 | 159.29 | 52.57 | 0 | 261.24 | 0.5 |
| Wolverine | 0 | 458.00 | 122.74 | 243.66 | 104.42 | 152.06 | 0 | 91.60 | 732.80 | 31.14 | 0 | 1,936.42 | 3.7 |
| River otter | 0 | 0 | 0 | 26.64 | 11.30 | 0 | 0 | 94.44 | 161.44 | 26.64 | 0 | 320.46 | 0.6 |
| Lynx | 348.98 | 1,691.91 | 199.84 | 1,392.92 | 510.04 | 247.56 | 0 | 1,888.05 | 2,982.70 | 745.68 | 0 | 10,007.68 | 18.9 |
| Red fox | 130.41 | 25.77 | 0 | 25.77 | 0 | 0 | 0 | 91.37 | 0 | 0 | 0 | 273.32 | 0.5 |
| Coyote | 36.48 | 121.84 | 24.08 | 85.36 | 0 | 0 | 0 | 24.08 | 0 | 24.08 | 0 | 315.92 | 0.6 |
| Wolf | 316.43 | 21.52 | 379.71 | 379.71 | 108.85 | 41.77 | 0 | 189.86 | 379.71 | 105.05 | 253.14 | 2,175.75 | 4.1 |
| Total | $2,377.00 | $3,352.65 | $814.33 | $5,237.65 | $4,399.44 | $1,739.39 | $7,781.02 | $7,679.55 | $12,844.49 | $3,519.85[b] | $3,365.93 | $53,100.30 | 100.1 |

| FURBEARER | Traplines in the West Portion | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | TL12 | TL13 | TL14 | TL19 | TL21 | TL22 | TL24 | TL25 | TL28 | Total West Portion traplines | Percent of West Portion |
| Beaver | $ 122.56 | $ 50.15 | $1,885.50 | $ 905.04 | $ 63.63 | $ 641.07 | $ 716.49 | $ 704.05 | $ 603.36 | $ 6,391.85 | 17.0 |
| Muskrat | 1.53 | 8.11 | 88.45 | 12.20 | 45.75 | 24.40 | 85.40 | 73.20 | 0 | 339.04 | 0.9 |
| Red Squirrel | 80.30 | 4.04 | 505.00 | 40.40 | 0 | 0 | 0 | 0 | 34.34 | 664.08 | 1.8 |
| Ermine | 3.75 | 2.14 | 2.14 | 0 | 0.54 | 0 | 0 | 0 | 0 | 8.57 | * |
| Mink | 70.13 | 93.51 | 155.85 | 124.68 | 194.81 | 197.31 | 155.85 | 207.90 | 0 | 1,200.04 | 3.2 |
| Marten | 550.91 | 1,567.87 | 1,003.15 | 1,315.60 | 1,110.04 | 569.98 | 920.92 | 1,425.12 | 296.01 | 8,759.60 | 23.2 |
| Fisher | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Wolverine | 137.40 | 122.74 | 0 | 183.20 | 45.80 | 0 | 0 | 0 | 0 | 489.14 | 1.3 |
| River otter | 0 | 0 | 121.08 | 0 | 0 | 0 | 0 | 0 | 161.44 | 282.52 | 0.8 |
| Lynx | 1,789.62 | 3,280.97 | 447.41 | 2,982.70 | 1,416.78 | 2,484.59 | 894.81 | 3,779.08 | 0 | 17,075.96 | 45.3 |
| Red fox | 58.57 | 25.77 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 84.34 | 0.2 |
| Coyote | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Wolf | 94.93 | 84.80 | 0 | 0 | 316.43 | 253.14 | 253.14 | 1,392.27 | 0 | 2,394.71 | 6.4 |
| Total | $2,909.70 | $5,240.10 | $4,208.58 | $5,563.82 | $3,893.78 | $4,170.49 | $3,026.61 | $7,581.62 | $1,095.15 | $37,689.85 | 100.1 |

[a] Fur harvest based on average annual returns, Table 7.

[b] * median incomes on East and West portion traplines.

[c] Less than 0.1 percent.

### 4.2.4 Fur Harvest in Comparison to Provincial Totals

The average number and value of furbearing mammals harvested on twenty traplines in the study area is compared to the corresponding seven year average of fur harvested in British Columbia. The mean total annual value of fur harvested on the twenty traplines in the study area is $90,790.15 (Table 9). This represents an average of 2.6 percent of the total provincial fur harvest value, and is proportionately higher than that expected (1.9%) based on the size of the trapping areas represented (Table 10).

The fur harvested on these trapping areas contribute from 0.1 percent to 14.6 percent of the provincial total of fur harvested from different species of furbearing mammals. The species of greatest economic importance, marten and lynx comprised 5.5 percent and 2.7 percent of the provincial totals, respectively, approximately two to three times that expected from the proportional size of these trapping areas. The traplines contribution of wolf and wolverine harvest (14.6% and 3.1%) was also greater than expected. The harvest of beaver, red squirrel and mink in the study area is similar to or slightly higher than expected while the harvest of the remaining furbearing mammals was less than expected from the proportional size of these trapping areas.

These comparisons do not necessarily reflect social or economic conditions that would influence the harvest of fur in the study area. Additionally, many species are not distributed throughout British Columbia. Thus a comparison of a reduced provincial area from which furs of a particular species could be harvested would increase the expected proportional catch in the study area and hence reduce the relative importance of the study area's contribution of these species. Species not found throughout British Columbia include muskrat, red squirrel, fisher, lynx, red fox and coyote.

Table 10. Number and value of pelts harvested on twenty traplines in the study area (Table 7) in comparison to fur harvested in British Columbia (mean of 1973-74 to 1979-80 seasons).

| | Mean Annual Harvest | | | | Percent of Provincial Total Harvest and Value |
|---|---|---|---|---|---|
| | British Columbia | | Study Area | | |
| | Harvest | Value[a] | Harvest | Value[a] | |
| Beaver | 19,063 | $ 718,856.73 | 425.7 | $16,047.11 | 2.2 |
| Muskrat | 34,283 | 209,126.30 | 109.9 | 670.45 | 0.3 |
| Red Squirrel | 65,561 | 132,433.22 | 1,801.8 | 3,639.49 | 2.7 |
| Ermine | 6,155 | 13,171.70 | 58.3 | 124.40 | 0.9 |
| Mink | 4,231 | 131,880.27 | 53.8 | 1,671.65 | 1.3 |
| Marten | 18,145 | 596,789.05 | 1,004.1 | 33,019.60 | 5.5 |
| Fisher | 936 | 149,095.05 | 1.6 | 261.24 | 0.2 |
| Wolverine | 423 | 77,493.60 | 13.4 | 2,425.56 | 3.1 |
| River otter | 905 | 73,051.60 | 7.5 | 602.98 | 0.8 |
| Lynx | 3,403 | 1,015,012.80 | 90.9 | 27,083.64 | 2.7 |
| Red Fox | 650 | 50,758.50 | 4.6 | 357.66 | 0.7 |
| Coyote | 3,845 | 280,531.20 | 4.3 | 315.92 | 0.1 |
| Wolf | 247 | 31,262.79 | 36.2 | 4,570.45 | 14.6 |
| Total | | $3,479,462.90 | | $90,790.15 | 2.6 |
| Area ($km^2$) | 948,600 | | 18,250[b] | | 1.9 |

[a] Values based on average of 1978-79 and 1979-80 fur prices (Appendix 4).

[b] Conservative estimate determined from reporting trapping areas in Figure 3.

## 4.3 Furbearing Mammal Abundance and Habitat Use

Fourteen species of furbearing mammals occur in the Liard River drainage. Seven species - - ermine, weasel, mink, marten, coyote, wolf, and red squirrel - - were recorded during the 1980 track-count surveys. Fisher, river otter, lynx and red fox that were recorded during track-count surveys in 1979 were not observed during 1980. Wolverine are reported in the fur harvest returns in relatively low numbers. Beaver and muskrat are aquatic species of furbearing mammals that are commonly reported from registered trapline returns. Two additional furbearers with big game status - - black bear and grizzly bear - - are known to occur in the study area. Only one black bear was reported in the fur harvest returns (Table 7). Bears are not further discussed in this report.

### 4.3.1 Beaver (*Castor canadensis*)

Beaver are rated fairly common in the study area. Beaver were caught on all but one trapline (Table 7). The total mean annual beaver harvest (425.7 beaver) represents a range of 0 to 75.0 beaver harvested per trapping area and a weighted average of 15.1 beaver per trapping area. The average number of beaver harvested in the study area represents 2.2 percent of the total provincial beaver harvest, slightly more than would be expected from the proportional size of these trapping areas (Table 10).

The Liard River and major tributary rivers in the study area generally provide poor beaver habitat in comparison to other regions of the boreal forest. The Liard River and major tributaries are generally incised in a floodplain, fairly fast-flowing, contain sand and gravel bars and are often subject to substantial seasonal water level fluctuations and ice scouring in spring. The mountainous terrain results in steep gradient streams that are generally unsuitable for damming by beaver. Suitable lakes, woodland ponds and slow-flowing streams and backwater channels of the larger rivers provide a limited amount of quality beaver

habitat in the study area. Observations during the winter track-count survey indicate that most suitable habitat support active beaver colonies.

### 4.3.2 Muskrat (*Ondatra zibethicus*)

An average of 109.9 muskrat pelts were harvested annually on the twenty reporting traplines (Table 7), an average of 5.5 muskrat per trapline. The weighted mean annual harvest (4.0 muskrat per trapline) is lower due to high catches reported from several lines with only one to three reporting years. The annual muskrat catch was considerably lower in the Eastern portion traplines (3.0) than in the Western portion traplines (6.6) (Table 7). The highest muskrat catches are reported from traplines south and west of Lower Post and east of the Rocky Mountains in the region of Site A to Nelson Forks. The study areas' contribution of the provincial muskrat harvest (0.3%) is low in comparison to that expected from its proportional size (Table 10). Muskrats contribute an average of 0.7 percent of trappers' fur harvest income in the area.

The wetland habitats in the study area generally provide poor muskrat habitat. Suitable lakes, ponds or marshes with emergent and submergent vegetation are infrequent. Areas in which low to moderate muskrat populations may be expected include the low-lying areas south and west of Lower Post and east of Site A.

### 4.3.3 Red Squirrel

The mean index of red squirrel activity in 1980 was 2.63 tracks per km-day (Table 2). This is higher than the abundance indices of red squirrels observed in the Western portion of the study area during 1979 (1.88 tracks per km-day) and the second highest index reported in tracking studies in the other regions of the boreal forest (Table 2). The higher squirrel population index in 1980 is believed to represent a more abundant population in the Eastern portion of the study area. However,

Fluctuations in red squirrel populations between years have been observed in other regions and usually relate to the availability of the source of their preferred food, white spruce cones (Brink 1964; Streubel 1968; Krasnowski 1969). The extremely cold temperature conditions which occurred during the track-count surveys in both years is expected to have similar dampening effects on above-snow activity by red squirrels. Snow depths in the Eastern portion during 1980 (10 to 30 cm) were considerably less than in the Western portion during 1979 (50 to 90 cm) and may have influenced greater above-snow activity by red squirrels in 1980. Red squirrel harvest in the Eastern portion (66.1 per trapline) is more than twice that in the Western portion (30.5 per trapline) (Table 7).

The sum of average annual harvest of 1801.8 red squirrels on twenty traplines in the area represents about 2.7 percent of the provincial fur harvest, somewhat more than would be expected from the proportional size of the study area (Table 10).

The track-count survey in 1980 indicated that red squirrels showed a preference for upland spruce forest, coniferous mixedwood forest and floodplain spruce - fir forest, and an avoidance of black spruce - wetland forest, burns, deciduous forests, riparian tall shrub, herbaceous and no cover (Table 4). Mixedwood forests in upland and valleybottom sites were used within the range expected according to availability. These observations are nearly identical to the red squirrel vegetation type selection observed previously (Penner 1979).

Red squirrels showed a general avoidance of wetlands and an apparent preference for slopes of 10 to 30% and 30 to 60% (Table 5). These slopes often support spruce dominated forests that are preferred by red squirrels.

### 4.3.4 Ermine

Both ermine (*Mustela erminea*) and weasel (*M. nivalis*) were recorded during the track-count survey during 1980. Because of the overlap in track characteristics of these species and because these species are not separately identified in the fur harvest returns, we have included both species under the heading of ermine. The proportion of ermine to weasel tracks per day were 6.1:1, based on our observations during the track-count surveys.

The mean density of ermine activity in 1980 was 2.05 tracks per km-day, considerably more than was observed in the Western portion of the study area during 1979 and is the highest index of ermine abundance recorded in track-count surveys in the boreal forest (Table 2). The differences in ermine abundance indices between years in the Liard River area may relate to differences in snow depths experienced between the track-count surveys. Under deep snow conditions, ermine may utilize the subnivean habitat extensively in search for prey. During the 1980 surveys the low snow depths may have affected greater surface travel by ermine. However, ermine populations often exhibit large fluctuations in numbers which coincide with the abundance of small mammal prey populations (Robina 1960; Erlinge 1964).

Fur harvest records show an average annual harvest of 58.3 ermine on twenty traplines in the Liard River drainage (Table 10). This represents about 0.9 percent of the total provincial ermine harvest during corresponding years, considerably less than would be expected from the proportional size of the study area. The average annual ermine catch per trapline was considerably greater in the Eastern portion traplines (3.3) than on Western portion traplines (0.6) (Table 7). These data support the findings during track-count surveys in 1979 and 1980 which indicate generally higher ermine abundance in the Eastern portion.

Ermine activity was observed in all vegetation and cover types in both 1979 and 1980 track-count surveys. During 1980 ermine showed a preference for deciduous mixedwood forest and burns with deciduous shrub vegetation types. Relatively high use of burn, with deciduous shrub, vegetation type were also observed for mink and marten, indicating a concentration of small predators within this habitat type. This habitat may support high local populations of small mammals. Small mammal trapping by B.C. Hydro (unpublished report) found burns with deciduous regrowth supported some of the higher small mammal trapping indices (15.4 captures per 100 trap nights) and the highest small mammal population diversity (7 species) (L. Goulet, pers. comm.).

During the 1980 track-count survey, ermine showed a general avoidance of black spruce-wetland forest, all floodplain forests and areas of no cover due to disturbance (Table 4). Other vegetation types were used in proportion to their availability. Ermine exhibited a preference for flat to undulating terrain and 30 to 60% slopes and a general avoidance of wetlands, valley bottom and 10 to 30% slope habitats (Table 5).

### 4.3.5 Mink (*Mustela vision*)

The mean density of mink activity was 0.15 tracks per km-day (Table 2). This abundance index is higher than that observed during the 1979 survey and was expected because the 1980 survey concentrated more on lowland and wetland habitats. Additionally, the low snow and open water conditions during the 1980 survey was expected to encourage greater surface travel than under the 1979 conditions.

The fur harvest returns show a sum of average catch of 53.8 mink on twenty traplines in the study area (Table 10). This represents 1.3

percent of the total mink harvest in the province, less than would be expected from the proportional size of the study area. Trappers in the Western portion reported a higher annual mink harvest (4.6 per trapline) than trappers in the Eastern portion (1.3 per trapline). Some of the highest mink catches were reported from traplines south and west of Lower Post (Table 7). Mink contributed an average of 1.8 percent of the average trapline income (Table 8).

The sample size of mink track observations in vegetation types was insufficient to allow statistical testing of habitat selection (Table 4). However, the data show relatively high use of burn, with deciduous shrub, and riparian tall shrub-grassland vegetation types by mink. High observed use of burns, with deciduous regrowth, by mink are possibly related to small mammal densities. The distribution of mink tracks observed was not significantly different from the availability of terrain features (Table 5). However mink activity was proportionately higher on wetlands than would be expected from the availability of these habitats. Table 6 compares the distribution of mink track activity observed in different wetland and shoreline types. The differences in observed use and habitat availability were insufficient to show a statistical difference in habitat use. However, the backwater channels (F5) and standing water wetlands (F6) use was proportionately greater than would be expected from the availability of the wetland types.

### 4.3.6 Marten (*Martes american*)

The mean density of marten activity was 2.79 tracks per km-day (Table 2). This index of abundance is considerably higher than that observed in the Western portion of the study area during 1979 (0.79 tracks per km-day) and one of the higher indices of marten abundance in track-count surveys in the boreal forest. The fur harvest records show a considerably higher annual marten harvest on Eastern portion traplines (60.4) than on Western portion traplines (30.1) (Table 7).

The sum of average annual harvest was 1004.1 marten from twenty reporting traplines (Table 10). This represents 5.5 percent of the total provincial harvest, approximately two and one half times that expected from the proportional size of the study area. Marten furs contributed an average of 36.4 percent of trappers' income in the study area (Table 8),(45.7% and 23.3% of trappers' income in the Eastern and Western portions, respectively, Table 9). The value of this harvest at current prices is $33,019.60.

The distribution of observed marten activity in 1980 was significantly different from the availability of vegetation types (Table 4). Marten showed a preference for spruce forest and burn, with deciduous shrub, habitats and a general avoidance of black spruce-wetland forest, burn, with lodgepole pine regeneration, floodplain deciduous and coniferous forest and no cover habitats. The other vegetation types were used in approximate proportion to their availability. During the 1979 track-count survey no significant difference was found between marten activity and availability of vegetation types.

R. Daloise (pers. comm.) reported that marten were very abundant in the Liard River region in 1980. He has observed relatively high densities of marten in burn areas and from observations felt that this habitat selection may be related to the abundance of berry forage available. R. Puttonen (trapper, pers. comm.) also reported localized abundance of marten near the Lower Liard Lodge and thought these animals were probably feeding on a locally abundant crop of huckleberries. Banfield (1974) indicated that fruits, insects and carrion are also eaten in addition to the major food source of small mammals and snowshoe hare.

Winter concentration of small mustelids however would probably relate to local abundance of small mammal populations. Relatively high use of burns with deciduous regrowth, were also observed for ermine and mink.

During the 1980 surveys, marten exhibited a preference for 10 to 30% and 30 to 60% slopes and a general avoidance of wetland and riparian/valleybottom habitats (Table 5). Flat to undulating terrain and steep slopes (60+% slope) were used in approximate proportion to their availability.

### 4.3.7 Fisher (*Martes pennanti*)

Fisher were not encountered during the 1980 track-count survey. The sum of average annual harvest of fisher on twenty traplines in the study area is only 1.6 fisher (Table 7). This represents 0.2 percent of the average provincial harvest, considerably less than would be expected from the proportionate size of the reporting trapping areas. Only one fisher track was encountered during the 1979 winter survey (Penner 1979). The fisher population in the Liard River drainage is considered to be low. The Liard River region is near the northern limit of fisher distribution (Banfield 1974).

### 4.3.8 Wolverine (*Gulo gulo*)

Wolverine tracks were not encountered during the track-count surveys in 1979 or 1980.

The fur harvest returns show an total average annual harvest of 13.4 wolverines (Table 10). This represents 3.1 percent of the total provincial harvest, nearly twice the amount expected from the proportionate size of the twenty reporting traplines. The average wolverine harvest per trapline was 0.7 wolverine (a range of annual averages of 0 to 4 wolverine per trapline) (Table 7). Wolverines contribute an average of 2.7 percent of the fur harvest value on these traplines (Table 8).

Quick (1953) reported that the abundance of wolverines in the Fort Nelson, British Columbia, area appeared to be one of the highest in Western Canada. He reported an average catch of 1.7 wolverine per trapline for two seasons of investigation. Wolverine densities in the Fort Nelson area were estimated to be 207 $km^2$ per animal (Quick 1953). The fur harvest returns for the study area also show a higher annual catch of wolverine in the Eastern portion (0.86 per trapline) than in the Western portion (0.30 per trapline) (Table 7).

Other comparative fur harvest records in northern British Columbia show annual wolverine harvests of 0.32 per trapline in the old M.A.22 (Ward 1979); 0.1 per trapline on 22 traplines along the Peace River (Penner 1976); 0.58 per trapline on 13 traplines in the McGregor and Parsnip river drainages (Penner 1977); and 0.21 per trapline on 9 lines in the Northeast Coal Block (Penner 1980). These comparisons indicate that the Liard River drainage is one of the better wolverine producing areas in British Columbia, in terms of number of wolverine harvested by trappers each year. The mountainous areas of British Columbia and Yukon maintain more stable and dense wolverine populations than other regions of Canada because of the abundance of natural refuges created by the relative inaccessibility of mountain habitat (Van Zyll de Jong 1975).

### 4.3.9 River Otter *(Lutra canadensis)*

River otter tracks were not encountered during the 1980 track-count survey. Only one otter track was recorded in 1979 on the Smith River. Fur harvest records show a total average annual harvest of 7.5 otter on twenty traplines (Table 10). This represents 0.8 percent of the total provincial harvest, less than one half that expected from the proportional size of the twenty traplines. The average otter harvest was similar on traplines in Eastern and Western portions of the study area (0.3 and 0.2 otter per trapline, respectively) (Table 7).

R. Puttonen (pers. comm.) reported several otter on the Deer River and harvested seven otter on his trapline during the last two trapping seasons. The distribution of otter harvested on various traplines described by Penner (1979) and the above data indicate that river otter may be locally common with family groups establishing a home range on suitable stream habitats in widely scattered parts of the study area. R. Daloise (pers. comm.) reported that river otter appear more common east of the Fort Nelson River than in the Liard River drainage.

4.3.10 Lynx (*Lynx lynx*)

Lynx tracks were not encountered during the 1980 winter track-count survey. During the 1979 survey the index of lynx abundance was 0.37 tracks per km-day, a relatively high index in comparison to other track-count surveys in the boreal forest region (Penner 1979). Lynx populations exhibit marked fluctuations that are associted with the well-known 10 year cycle for snowshoe hares (Keith 1963, 1974). The snowshoe hare abundance index in 1980 (7.72 tracks per km-day) was about one third of that recorded in 1979 (21.48 tracks per km-day) (Table 2) indicating that the snowshoe hare population probably peaked during 1979-80 and has since declined in abundance. R. Daloise (pers. comm.) reported that pockets of high densities of snowshoe hare still occurred during 1980 but the general population abundance was lower than in the previous year. Nellis *et al.* (1972) reported that peak lynx population during the 1961-62 season near Rochester, Alberta coincided with the peak snowshoe hare population.

The total mean annual harvest was 90.9 lynx on the twenty traplines (Table 10); an average of 4.3 lynx per trapline per year (Table 7). This harvest represents 2.7 percent of the total provincial harvest, somewhat more than expected from the proportional size of the study area (Table 10). Lynx pelts contributed an average of 29.8% of the value

of the fur harvest to trappers on the twenty reporting traplines in the study area (Table 8). Based on the average 1978-1979 and 1979-1980 fur prices, this harvest was worth $27,083.64.

The average lynx catch in the Eastern portion traplines (4.0 lynx per trapline) was less than in Western portion traplines (6.8 lynx per trapline) (Table 7). The 1979 track-count survey also obtained a higher index of lynx abundance on transects in the Western portion in comparison to transects near the Eastern portion of the study area (Penner 1979). The burn, with deciduous shrub, vegetation type, which was the highly preferred lynx habitat during the 1979 surveys, was only present and sampled in low amounts during the 1980 surveys in the Eastern portion of the study area.

The average lynx catch per trapline each year since 1973-1974 is 3.9 (Appendix 5). The highest lynx harvest in the study area averaged 11.2 lynx per trapline in 1973-74 and then declined to a low of 1.3 lynx per trapline in 1977-78. The 1979-80 average catch was 3.6 lynx per trapline.

4.3.11 Red Fox (*Vulpes vulpes*)

Red fox tracks were not encountered during the 1980 track-count survey. In 1979, the index of red fox abundance was 0.01 tracks per km-day, one of the lowest indices reported for track-count surveys in the boreal forest region (Table 2).

The total mean annual harvest of red fox was 4.6 pelts on twenty reporting traplines in the Liard River drainage (Table 10). This harvest represents 0.7 percent of the provincial total; less than half that expected from the proportional size of the study area. The average catch is 0.3 fox per trapline (Table 7).

Based on the above information, the red fox is expected to occur in relatively low numbers in the study area. Red fox populations may however show regular fluctuations in abundance in eight to ten year cycles (Van Zyll de Jong 1970; Banfield 1974). R. Daloise (pers. comm.) reported that from his observations, red fox populations appeared relatively abundant in localized areas during the 1980-81 season.

4.3.12 Coyote (*Canis latrans*)

Coyote tracks were not encountered during the 1980 track-count survey. The index of coyote abundance recorded during the 1979 survey was 0.01 tracks per km-day (Table 2).

The mean annual harvest of coyote was 4.3 pelts on twenty traplines (Table 10). This represents 0.1 percent of the provincial total, considerably less than would be expected from the proportional size of the study area. All coyote pelts reported came from the Eastern portion traplines (Table 7). During the 1979 track-count survey, coyote tracks were recorded only in the vicinity of the Trout River and Lower Liard River Crossing.

While the coyote is adaptable to many habitat types, it prefers semi-open deciduous forests with moderate topographic relief (Banfield 1974). The conifer dominated forests that are prevalent in the study area are considered poor coyote habitat.

4.3.13 Wolf (*Canis lupus*)

Wolf tracks were encountered in four locations during the 1980 track-count survey for a mean index of 0.03 tracks per km-day (Table 3).

The mean annual wolf harvest was 36.2 pelts on twenty traplines (Table 10). This represents 14.6 percent of the provincial total, considerably more than would be expected from the proportional size of the study area. This harvest constitutes an average of 5.0 percent of the value of fur harvested (Table 9) on the reporting traplines in the study area. The average annual wolf harvest on Western portion traplines (2.5 per trapline) was nearly twice that reported for Eastern portion traplines (1.4 per trapline) (Table 7).

Figure 4 depicts the distribution of reported wolf sightings that are tabulated in Appendix 6. The probable distribution of eleven wolf pack ranges are delineated (Figure 4). The general locations of these pack ranges are based on reported pack observations, topographic features such as major river valleys, plateaus and mountain ranges and occurrence of local ungulate concentrations. Additional wolf packs would be expected in the following areas based on landforms and the distribution of major tributaries to the Liard River: Hyland River, Smith River, Crow-Beaver rivers near Site A, Fort Nelson-Dunedin rivers, Dease-Tatisno rivers, and Red Deer-upper Dease rivers.

Wolves which prey upon non-migratory ungulate prey usually establish generally exclusive territories (Mech 1970). While pack movements in winter are normally quite extensive, a compression of a wolf packs home range may occur as a result of prey concentration (i.e. on ungulate winter ranges) (Cowan 1947; Kolenosky 1972; Kuyt 1972).

The territory sizes of individual wolf packs have been reported in several studies and generally range from 100 to 300 $km^2$ (maximum range 88 $km^2$ to 1295 $km^2$) (Mech 1966; Van Ballenberghe *et al.* 1975; Thompson *et al.* 1980). Wolf densities in these studies generally fall into two ranges: 20 to 50 $km^2$ per wolf and 100 to 300 $km^2$ per

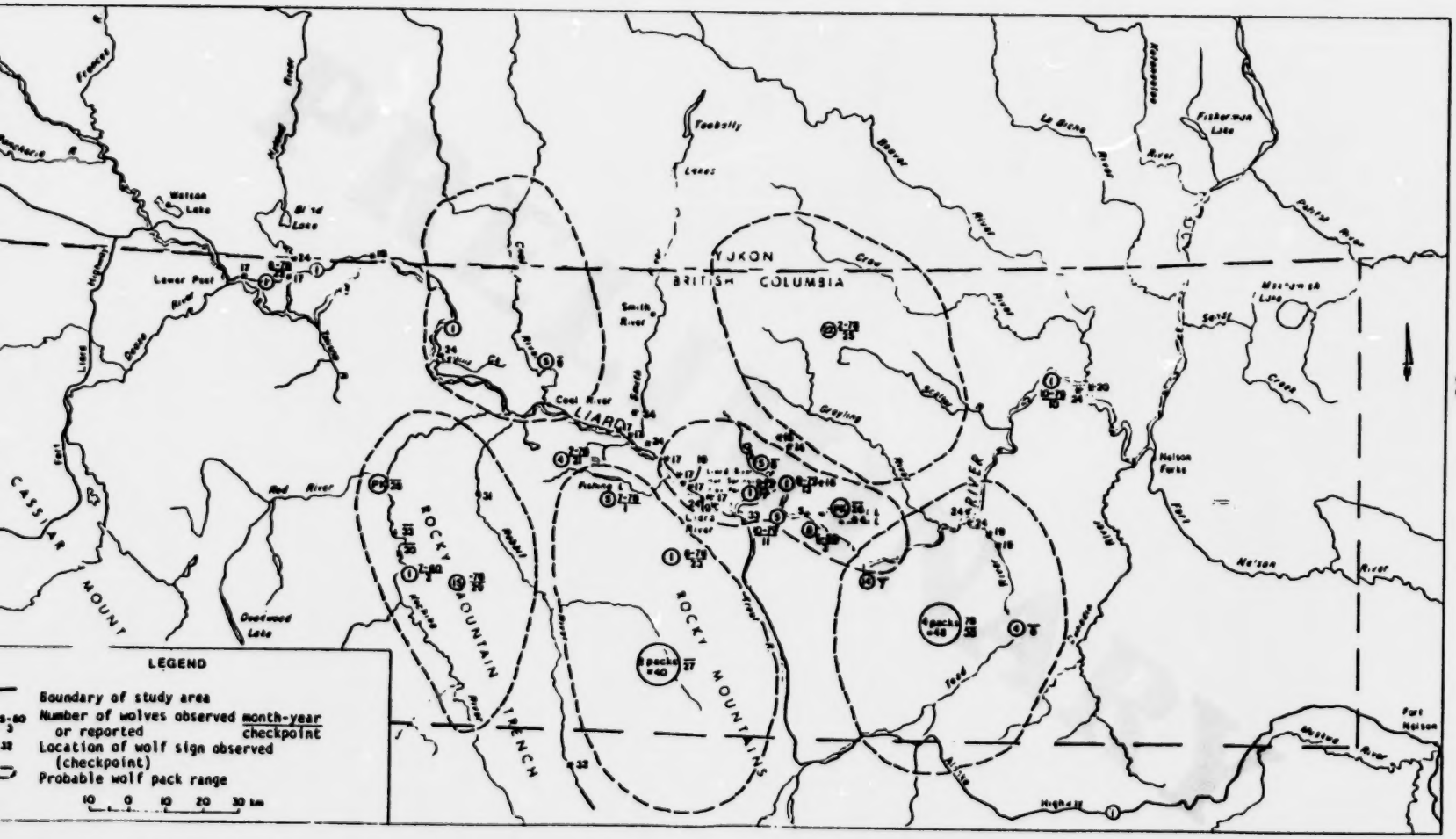


Figure 4. Distribution of wolf sightings (Appendix 6) and location of probable wolf pack ranges in the Liard River drainage, British Columbia.

wolf (maximum range 12 to 520 $km^2$ per wolf) (Mech 1970; Thompson *et al.* 1980). Bergerud (1978) and Fish and Wildlife Branch (1979) report the density of wolves in six areas of northern British Columbia. Wolf densities range from one wolf per 85 $km^2$ to one wolf per 171 $km^2$. These values provide an average estimated density of one wolf per 110 $km^2$. The Toad River Hot Springs area was reported to support four wolf packs, averaging 12 wolves per pack, and a density of one wolf per 85 $km^2$. L. Goulet (pers. comm.) reported that J. Elliot (B.C. Fish and Wildlife, Fort St. John) observed an average density of one wolf per 132 $km^2$ in a study area near the Liard River drainage. Observed pack sizes ranged from 1 to 16 wolves and averaged 7 wolves per pack.

During winter surveys for caribou, Bergerud (1973) reported wolf activity on most rivers on the Rabbit River (94M), Tuchodi (94K) and Toad River (94M) map sheets. Wolf pack distributions are often associated with local concentrations of ungulates. The wolf populations in the Liard Plateau and Rabbit River areas overlap with ranges of several caribou herds (Bergerud 1978). The Norquist Lake area supports a population of elk and is an important wintering area for moose and a smaller number of mule deer (King, pers. comm. *In:* Arcon 1978). Moose surveys along the Alaska Highway Gas Pipeline reported average densities of 0.52 moose per $km^2$ (Lincoln 1979). The highest densities of moose were generally found in upland habitats between the Liard River Crossing and the Grayling River and east of the Toad River. The available information on moose distribution do not identify the valley bottom habitats of the Liard River as important moose winter range. Thus it is assumed that the important habitats for wolves are the tributaries and upland habitats adjacent to the Liard River that support the major proportion of ungulate prey. Valley bottoms and water courses are frequently used by wolves as travel corridors.

The above information indicates that wolves are common in the Liard River drainage. Wolf pack ranges are expected to be distributed throughout the study area and encompass most of the available habitat.

### 4.3.14 Snowshoe Hare (*Lepus americanus*)

The mean density of snowshoe hare tracks during the 1980 survey was 7.72 tracks per km-day (Table 2). This abundance index is considerably lower than that observed during the 1979 track-count survey (21.48 tracks per km-day) in the Western portion of the Liard River drainage. With the exception of the transects in the area of Trout and Deer rivers and Liard Hot Springs, snowshoe hare track indices in the other areas were all of low to moderate abundance (2.13 to 9.19 tracks per km-day) (Appendix 1). These data support the observations of R. Daloise (pers. comm.) that the snowshoe hare population has generally declined since 1979 but still occur in pockets of relatively high abundance. The snowshoe hare population is apparently in the declining phase of its cyclical population fluctuations. The fluctuations in the snowshoe hare population have been shown to roughly follow a ten year cycle (Keith 1963, 1974; Keith and Windberg 1978). Keith and Windberg (1978) reported that peak snowshoe hare populations near Rochester, Alberta, occurred during the 1961-62 and 1970-71 seasons. The population peak in 1979-80 and apparent decline in 1980-81 in the Liard River region is thus only slightly advanced from that anticipated (Penner 1979).

During the 1980 studies, observations of snowshoe hare tracks were recorded in most vegetation types sampled (Table 4), A preference was indicated for spruce forest and burns, with lodgepole pine regeneration. The relatively high use of burns was also observed during the previous track-count surveys (Penner 1979). Burns, with deciduous regrowth, floodplain deciduous and mixedwood forests and areas with no cover-disturbance were used by snowshoe hare in approximate proportion to the availability of these types. The remaining vegetation types were used significantly less than expected according to their availability, indicating a general avoidance of these vegetation or cover types.

Snowshoe hares were recorded in all terrain types and exhibited a preference for valley bottom, flat to undulating uplands and 30 to 60 percent slopes (Table 5). Wetlands and 10 to 30% slopes were generally avoided.

The relatively high use of F4 (small, slow-flowing streams) and F5 (backwater channels) wetland types and low cutbank and treed shorelines reflect the snowshoe hare's normal association with shrub and tree cover (Table 6).

Keith (1963) reviewed the changes in snowshoe hare distribution in relation to population fluctuations and found that during years of low abundance, snowshoe hares persisted in restricted islands of favored habitat. These populations dispersed into less favorable habitat as their numbers increased. Snowshoe hare habitat preference was found to relate directly to the amount of dense brushy cover available (Keith 1966). Comparison of habitat selection by snowshoe hares observed during the 1979 and 1980 track-count surveys shows that the vegetation regrowth following burns is the preferred habitat used by snowshoe hares in the Liard River drainage.

The snowshoe hare is an important prey item of many carnivorous furbearers, particularly during snowshoe hare population peaks. As the snowshoe hare population declines, a related decrease in the abundance of some furbearers will also occur. The absence of lynx track observations during the 1980 survey may already reflect this relationship.

# 5.0 IMPACT ASSESSMENT

Table 11 provides a summary of the potential impacts that are anticipated from various development phase activities, the level and significance of the potential impacts and mitigation measures that may avoid or reduce the potential impacts.

## 5.1 Potential Impacts

### 5.1.1 Potential Impacts on Furbearing Mammal Populations

The main negative impacts on furbearing mammals from a hydroelectric development on the Liard River will occur as a result of habitat alteration and habitat loss during vegetation clearing and flooding of the reservoirs (Table 11). These project actions will affect between 69,100 and 116,600 hectares of habitat, depending upon the hydroelectric scheme chosen (Table 12). These habitat losses will result in a reduction of those furbearing mammal populations dependent on the area in proportion to the population densities and the amount and importance of habitats made unavailable to these animals.

Hydroelectric Scheme 7, involving reservoirs from dam sites A, F and G would have the greatest impact on furbearing mammals due to the large amount of habitat flooded (116,600 ha) (Table 12). Scheme 7, would also affect the greatest amount of valley bottom habitats.

Hydroelectric Scheme 2 would flood slightly less furbearer habitat (105,900 ha) than Scheme 7 and would affect different proportions of the various vegetation types due to different elevations of full supply levels in the proposed reservoirs. Hydroelectric Scheme 2 would result in greater furbearer habitat losses in the region

**Table 11. Preliminary assessment of the potential impacts on furbearing mammal populations from hydroelectric developments on the Liard River, British Columbia.**



| Development Phase<br>Activities | Potential Impacts | Level and Significance of Impact<br>Magnitude: Duration<br>Nature; Value | Mitigation Measures |
|---|---|---|---|
| 1.0 CONSTRUCTION OF A DAM AND HYDROELECTRIC GENERATING FACILITIES | | | |
| 1.1 Pre-construction phase<br>Survey activities | -- habitat loss due to disturbance, affecting most species | low: short-term reversible; negative | -- schedule survey activities to avoid critical seasons; late winter and spring |
| | -- disturbance from site specific interactions | low: short-term reversible; negative | -- as above |
| 1.2 Construction phase<br>Vegetation removal, site development, building of dam and site facilities | -- habitat loss from habitat alteration and disturbance, affecting most species | moderate: long-term reversible; negative | -- limit clearing to essential areas; rapid reclamation following construction |
| Access roads and vehicle activity | -- habitat loss from habitat alteration and disturbance, affecting terrestrial furbearers | moderate: long-term irreversible; negative | -- limit clearing to essential right-of-way width; reclaim ditches to herbaceous cover |
| | -- direct mortality from accidental road kills, most terrestrial species | low: short-term reversible; negative | -- establish speed limits, posting of wildlife crossing areas |
| Borrow pits | -- habitat alteration resulting in habitat loss or gain to different species | low: long-term reversible; negative and positive | -- locate borrow pits within impoundment area or select sites which avoid important habitat |
| Construction camps and work crews | -- habitat loss from habitat alteration and disturbance; habitat alteration may benefit some species following abandonment | low: long-term reversible; negative and positive | -- select and design actions to improve habitat following abandonment; reclamation of disturbed areas |
| | -- direct mortality of problem wildlife (e.g. bears) and from increased hunting by work crews | low: short-term reversible; negative | -- establish a solid waste disposal plan to prevent attraction or access to garbage by bears or other scavengers |
| Industrial waste and fuel spills | -- terrestrial and aquatic habitat degradation | low: long-term reversible; negative | -- establish an industrial waste disposal plan to prevent seepage of toxic materials to aquatic habitats and to prevent accidental fuel spills |
| | -- direct mortality of aquatic furbearers through contact with toxins and toxin accumulation in food chains | low: long-term reversible; negative | -- same as above |
| 1.3 Operations and maintenance phase<br>Dam structure and site facilities | -- habitat loss affecting most species of furbearers | low: long-term irreversible; negative | -- none known |
| Operations and maintenance personnel | -- habitat loss due to disturbance affecting terrestrial species | low: long-term irreversible; negative | -- none known |
| 2.0 IMPOUNDMENT | | | |
| 2.1 Construction phase<br>Logging and vegetation clearing | -- habitat loss from habitat alteration and physical destruction plus disturbance affecting most species of furbearers resulting in indirect mortality (within one year) of the resident furbearers | high: long-term irreversible; negative | -- none known |
| 2.2 Operations phase<br>Flooding of impoundment | -- habitat loss due to flooding affecting all species of furbearers | high: long-term irreversible; negative | -- none known |
| | -- habitat alteration due to groundwater effects on water table adjacent to the reservoir; loss and gain to different species | moderate: long-term irreversible; positive and negative | -- none known |
| | -- direct mortality during flooding operations | low: short-term irreversible; negative | -- none known |

| Development Phase Activities | Potential Impacts | Level and Significance of Impact Magnitude: Duration Nature; Value | Mitigation Measures |
|---|---|---|---|
| **3.0 NEW ACCESS ROADS AND HIGHWAY RELOCATIONS** | | | |
| 3.1 Pre-construction phase Survey activities | -- habitat loss due to disturbance affecting most species | low: short-term reversible; negative | -- schedule survey activities to avoid critical seasons (late winter and spring) |
| 3.2 Construction phase | -- habitat loss from habitat alteration and disturbance, affecting most species; some habitat gains by species adapted to early seral stages of vegetation (e.g. ermine) (Note: that for highway relocations, this impact replaces the losses caused by the original highway). | moderate: long-term irreversible; negative and positive | -- design highway to avoid important habitats, crossing of riparian zones and streams at right angles to reduce loss of important habitats; reduce clearing to minimum right-of-way; rapid reclamation of right-of-way |
| 3.3 Operations Phase Increased vehicle activity | -- habitat loss from disturbance | low: long-term reversible; negative | -- design highway to avoid important furbearer habitats |
| | -- disturbance from site specific encounters of furbearers and traffic | same as above | -- same as above |
| | -- direct mortality from accidental collisions with vehicles | low: long-term reversible; negative | -- posting of wildlife crossing areas; establish speed limits, especially at crossing areas |
| Increased access | -- direct mortality from increased hunting pressures (noteably on furbearers that can also be harvested by recreational hunters (e.g. wolf, coyote, wolverine, lynx and fox) | low to moderate: long-term reversible; negative or positive | -- cooperation with the Fish and Wildlife Branch to expidite any management changes that might arise from the development |
| **4.0 SETTLEMENT RELOCATIONS** | | | |
| 4.1 Construction phase | -- habitat loss through vegetation clearing and disturbance (this impact replaces those associated with the settlement that may be replaced) | moderate: long-term irreversible; negative | -- site requirement for a new settlement is expected to take precedence over protection of furbearer habitat requirements and any location will affect some species of furbearers |
| 4.2 Operations phase | -- habitat loss through habitat alteration and disturbance | moderate: long-term irreversible; negative | -- as above |
| **5.0 TRANSMISSION LINE** | | | |
| 5.1 Pre-construction phase Survey activities | -- habitat loss due to disturbances affecting most species | low: short-term reversible; negative | -- schedule survey activities to avoid critical seasons |
| 5.2 Construction phase Vegetation removal and line erection | -- habitat alteration, habitat losses or gains for different species of furbearers, aquatic habitat degredation may result from situation | moderate: long-term reversible; positive and negative | -- design of transmission line alignment to avoid important furbearer habitats; removal of slash by chipping or scarification; cross streams at right angles; rip-rap and reclamation to prevent erosion, reclamation to herbaceous and shrub cover |
| | -- disturbance affecting primarily terrestrial species | low: short-term reversible; negative | -- schedule activities to avoid important habitats at critical seasons |
| 5.3 Operations and maintenance Right-of-way maintenance (mechanical and/or chemical control of vegetation) plus line maintenance | -- habitat alteration, restriction of shrub and tree growth resulting in losses or gains to different species of furbearers | low: long-term reversible; negative or positive | -- design of habitat management plan for optimum wildlife use compatable with transmission line maintenance, reclamation should encourage herbaceous and shrub species; travel lanes should be planted to optimize habitat use. |
| | -- disturbance affecting most terrestrial species | low: short-term reversible; negative | -- none known |
| Increased access | -- direct mortality of furbearers due to increased trapping or hunting activities | low to moderate: long-term reversible; negative and positive[a] | -- cooperation with the Fish and Wildlife Branch to expidite any management changes that arise from the development |

[a] Increased resource use may be positive or negative, depending on local wildlife management goals.

Table 12. Approximate areas (in hectares) of the reservoirs in each of the proposed Liard River hydroelectric schemes.[a]

| Hydroelectric Scheme | Dam Sites | Area of Reservoirs (ha) |
|---|---|---|
| Scheme 2 | Site E | 87 200 |
| | Site A | 18 700 |
| | | 105 900 |
| Scheme 7 | Site G | 68 300 |
| | Site F | 5 700 |
| | Site A | 42 600 |
| | | 116 600 |
| Scheme 8 | Site G | 20 800 |
| | Site F | 5 700 |
| | Site A | 42 600 |
| | | 69 100 |

[a] Data from Industrial Forestry Service Ltd. (1979), Liard River Forest Resource and Reservoir Clearing for B.C. Hydro and Power Authority.

upstream of the Liard River Hot Springs (Western portion) than under Scheme 7. Hydroelectric Scheme 8 would result in the least overall impact on furbearing mammals due to the relatively low amount of habitat flooded (69,100 ha).

Regardless of the hydroelectric scheme chosen, all furbearing mammal populations in the area will be affected to some degree because the reservoirs will flood portions of nearly all vegetation and wetland habitats in the study area. Populations of furbearing mammals that are dependent on valley bottom habitats will be more severely affected than furbearers that prefer upland forest and shrub vegetation types. Permanent habitat loss caused by impoundment flooding is considered to cause impacts of high magnitude and of long-term duration.

Impacts of moderate magnitude and long-term duration are expected to occur as a result of the following project actions: construction of hydroelectric dam structures, construction of access roads and highway relocations (Table 11). These project actions will result in the alteration or loss of varying amounts of habitat. As an example, the order of magnitude of habitat alteration would approximate 100 to 200 ha for each dam construction site, 10 to 30 ha for settlement relocations and 300 ha per 100 km of road or transmission line with a 30 m right-of-way.

Reclamation and natural succession will, within several years, restore herbaceous cover to about half the road and most of the transmission line rights-of-way. This will provide habitat used by such species as meadow voles, passerine birds and other species of wildlife preyed on by carnivorous furbearers (e.g. ermine and marten). Invasion of shrubs and trees, in about 3 to 10 years will provide habitat for species using forest edge habitats such as moose and snowshoe hares which provide prey for wolves, lynx and other furbearers.

However, the use of these new habitats along the right-of-way (particularly roads) may be influenced by other factors, primarily disturbance by vehicle traffic, which will result in habitat avoidance by the larger furbearers which are sensitive to disturbance. Although some habituation to vehicle traffic may occur, hunted furbearers, such as wolves, and secretive species such as marten, lynx and wolverine, are usually wary and generally avoid areas of human activities. These impacts are generally of low magnitude and of long-term duration, resulting in minor reductions of the furbearing mammal populations.

Vehicle traffic on access roads is expected to result in some direct mortality of furbearing mammals as a result of accidental collisions. The magnitude of this impact is low (i.e. affecting a small proportion, less than 1% of the population) and will continue for the duration of the operations phase.

Part of the habitat altered by the dam construction sites can be reclaimed following the construction phase, thereby allowing prey species and thus furbearing carnivores to reinhabit these areas. The dam structures (per se) and the settlements will results in a long-term habitat losses.

The extraction of aggregate from borrow pits will result in the alteration of terrestrial habitat; for most species this will represent a long-term habitat loss (i.e. vegetation establishment and succession may be extremely slow on course aggregate and subsoils). If borrow pits are located in sites where they will be shallowly flooded, they may provide a habitat gain for some aquatic furbearers, such as beaver and muskrat. Appropriate reclamation design may enhance terrestrial and aquatic habitat development to reduce the duration of this impact.

The most widespread impacts will result from discontinuous disturbances to furbearers during survey and construction phases, vehicle traffic and maintenance operations. This impact is generally of low magnitude and will result in minor reductions to most furbearing mammal populations.

Maintenance of access roads and transmission line rights-of-ways will continue to affect the habitat along these structures by retarding shrub and tree growth. The maintenance of early seral stage vegetation along these rights-of-way will benefit some furbearers such as ermine and coyotes but will not benefit forest dwelling species such as red squirrels. This impact is of low magnitude and long-term duration.

Construction camps and work crews will cause habitat loss to furbearers from habitat alteration and disturbance, respectively. Following abandonment and reclamation of these sites, the alteration of forest cover to earlier successional stages of vegetation will benefit some species of furbearers as has been discussed above. Both positive and negative impacts of this project action are of low magnitude and of long-term duration.

The new access roads, highway relocation and transmission line corridors will provide increased access for recreational hunting and for trapping. To the furbearing mammal populations, this impact will be negative, of low to moderate magnitude and of long-term duration. However, the increased fur harvest by hunters or trappers may be desirable or undesirable depending on the goals for the management and exploitation of these species. In the recent past, the legal harvest of furbearers by hunters and trappers has generally not threatened the survival of furbearing mammal populations. However, an increase in the kill (harvest) of furbearers resulting from increased access may require altered management strategy to protect furbearing mammal populations.

In summary, the main negative impacts of a hydroelectric development on furbearing mammal populations will occur from habitat alteration and habitat loss through reservoir clearing and flooding (a long-term impact of high magnitude). Habitat alteration will also occur as a result of vegetation clearing at construction sites, at construction camps, along access roads, relocated highway and transmission lines, and at new settlement locations (low to moderate, long-term impacts). Short-term habitat avoidance will result from disturbances associated with construction activities. These impacts will result in the reduction of the various furbearing mammal populations in proportion to their density in each vegetation type and the amount of habitat altered or made unavailable. Reclamation of rights-of-ways and abandoned construction sites will be a long-term positive impact by allowing the recovery of vegetation and thus some mammal populations. Potential impacts resulting in the mortality of low numbers of furbearing mammals will result from stress-related disturbances and direct mortality (e.g. increased hunting and trapping, increased access and accidental collisions with vehicles).

The main impacts and reductions to the various furbearing mammal populations that result through habitat loss from reservoir flooding and the operations phases of the development are expected to be permanent. That is, the life span of the proposed reservoirs are expected to be in the order of thousands of years for Regions G and E and many hundreds of years for Region A, assuming a progressive downriver development (British Columbia Hydro and Power Authority 1978).

The magnitude of these impacts are placed in perspective through the following considerations:

1. The populations of furbearing mammals which will be affected are part of larger regional populations (i.e. the Liard River drainage or greater (the Boreal Forest Region)).

The hydroelectric development will adversely affect approximately one percent of the surface area of the Liard River drainage.

2. The impacts of this development are expected to result in the reduction of most populations of furbearing mammals of approximately one percent of the regional populations (exceptions are wolves which are seasonally dependent on valley bottom habitats and aquatic furbearers such as beaver, muskrat, mink and otter, whose populations within the development area would represent more than one percent of the regional population).

3. Greater fluctuations in population numbers may be expected from natural habitat changes (i.e. fire and succession) and population fluctuations (i.e. cycles) than from the population fluctuations caused by this development. Natural fluctuations imply the capability of recovering former population sizes. Habitat loss, such as would occur from reservoir flooding would permanently reduce the capability of the region to support former population numbers within their natural range of fluctuations (i.e. the long-term mean population size will be permanently reduced).

This assessment considers the potential impact of the Liard River hydroelectric development independently of other resource use and development activities which may also adversely affect the same wildlife populations. The cumulative effects of this development and other resource developments in the Liard River drainage over the life span of the development should be considered in assessing the incremental effects of this development on populations of furbearing mammals.

### 5.1.2 Potential Impacts on Furbearer Resource Use

The proposed hydroelectric development can affect the fur resource use in two ways: 1) by directly and indirectly affecting the furbearing mammal populations (i.e. a decrease or increase in populations caused by various project actions) and 2) by interfering with and otherwise influencing furbearer harvesting activities.

1. A negative impact on the furbearer resource use will result from the reductions in furbearing mammal populations caused by the flooding of the impoundments. Other project activities associated with the pre-construction, construction and operations phases of the development, will also cause reductions in the furbearing mammal populations as a result of habitat alteration, disturbance and direct mortality. The land area affected by this development is a small proportion, approximately one percent (Scheme 2 or 7), of the Liard River drainage above Site A. However, the valley bottoms are more productive habitats for furbearing mammals such as mink, beaver, and otter than upland habitats.

2. Three user groups will be affected by the reduction of furbearing mammal populations caused by the proposed hydroelectric development: trappers, recreational hunters and non-consumptive recreationalists. Of these, trappers will be the most directly affected. Recreational hunters harvest relatively low numbers of furbearing animals; wolves are the major species harvested (B.C. Fish and Wildlife Branch). Data are unavailable to assess the importance of furbearers to non-consumptive recreationalists. Non-consumptive use of furbearers is expected to be low at the present time but often constitute a highlight of an outdoors experience if uncommon furbearers are seen (or heard in the case of wolves).

3. Thirteen registered trapping areas would be directly affected by the proposed hydroelectric developments between Site A and Lower Post. The proposed hydroelectric schemes would inundate between 2 and 3 percent of the land area of these traplines. Downstream effects of the hydroelectric development on furbearer habitat plus the potential impacts resulting from access roads and transmission lines may influence the trapping operations on several additional trapping areas. The main impact on trappers will result from the disruption of existing harvest patterns based on established traplines.

4. New access roads and transmission lines may provide increased access for trappers to new locations or improve trapper movements on their trapping areas, thus increasing the trappers' potential for harvesting fur on their area. This would be a long-term positive impact to some trapping operations.

5. New access roads and transmission lines will also provide increased access for recreational hunters. This may result in an increased kill of furbearers harvested as game species (i.e. wolf, wolverine, coyote and lynx). Increased kill of these species due to the increased access may conflict with the harvest of these populations by trappers. An increase in the fur-game harvest in the vicinity of the development may occur when employees associated with the development harvest fur-game on an opportunistic basis.

6. The new access, particularly transmission lines, may increase the access to new country to recreationalists using snowmachines and all-terrain vehicles. These activities often

result in a disturbance to wildlife and may influence the distribution and production of furbearing animals and thus the fur harvest by trappers.

7. Construction activities may interfere with trapping operations through inadvertent destruction or damage to traplines, traps and trap sets. Traplines are often established along lightly used or abandoned roads, trails and seismic lines. The reclearing of such roads or seismic lines may damage established traplines. Clearing activities may also create brush pile "barriers" across traplines, thereby causing inconvenience to trappers travelling their lines on snow machines or dog teams.

8. Reservoir flooding will destroy traplines, trap sets and trapper cabins located below the flood level. The impoundment may also interfere with trapper movements to established portions of their trapline in early winter, as the reservoir is not expected to freeze over as early as the Liard River.

9. Construction personnel may cause problems for trappers through theft or vandalism of trapper's equipment and supplies cached in the bush or near trapper's cabins. Theft of fur, equipment and supplies and vandalism of trapping sets or cabins is a common concern voiced by trappers. "Poaching", either premeditated or casual may also occur as a result of the increased access to new areas by recreational user groups.

10. Reclamation of road and transmission line rights-of-way and reclamation of construction sites and construction camps following their abandonment will provide new habitats of

herbaceous cover and provide habitat diversity in areas of climax coniferous forest. This will benefit animal populations such as small mammals, snowshoe hares, moose and deer, which are preyed upon by different furbearers. Trappers interviewed by Ward (1978) felt areas were enhanced by reclamation such as seeding of the rights-of-ways.

## 5.2 Mitigation Measures

### 5.2.1 Mitigation Measures for Furbearing Mammal Populations

The main impact on furbearing mammal populations that will occur as a result of habitat loss from reservoir flooding cannot be avoided. However, appropriate development and reclamation design can reduce the magnitude and duration of some adverse impacts on furbearing mammal populations.

1. Selection of the least detrimental hydroelectric scheme will provide the greatest reduction of the main negative impacts. The furbearing mammal inventory data (from the track-count surveys in 1979 and 1980 and fur harvest records) show no consistent trends in regional abundance of all furbearers. The East portion traplines show a slightly higher annual return from fur harvested per trapline than the West portion traplines (Table 8). Marten and lynx provide the greatest proportion of trapping income (36.4% and 29.8% respectively).

Of the three proposed Liard River hydroelectric schemes (2, 7 and 8), Scheme 8 is considered to have the least overall detrimental effect on furbearing mammal populations. The main consideration is the amount of valley bottom and

terrestrial habitat that would be lost due to reservoir flooding. Scheme 8, with three dam sites (G, F and A) would flood approximately 69,100 ha, where as Scheme 2 and 7 would flood approximately 105,900 and 116,600 ha of habitat respectively (Table 12). Scheme 8 would have the least overall impact on furbearing mammal populations.

2. The reservoir will provide a large water body with an irregular shoreline that has potential for some aquatic habitat development suitable to support aquatic furbearers (mink, otter, muskrat and beaver). To optimize aquatic habitat development, B.C. Hydro would have to manage water levels at a relatively constant level (i.e. within 0.5 m) or regulate them to resemble a "natural" hydrological cycle of seasonal fluctuations. Aquatic habitat development can be further enhanced by contouring of reservoir slopes along suitable shorelines to encourage emergent and submergent aquatic vegetation and deciduous riparian vegetation.

3. Habitat loss from intensive land-use facilities such as construction sites, access roads, transmission lines and settlement relocations may be reduced by limiting vegetation clearing to that essential for construction and operations. To reduce the duration of habitat loss from vegetation clearing, all sites should be reclaimed immediately following completion of construction and abandonment of facilities.

Reclamation of disturbed areas for the restoration of wildlife habitat requires the following considerations in the reclamation design.

a) Contouring of terrain to suitable slopes to provide proper drainage and to prevent excess moisture run-off which in turn prevents erosion and siltation. Provision of different

exposures (e.g. south-facing slopes) will establish habitat diversity. Depressions such as borrow pits which will develop into wetlands should be contoured to encourage riparian, emergent and aquatic vegetation growth.

b) Revegetation should provide the rapid establishment of ground cover to prevent erosion followed by the establishment of trees and shrubs. In areas where the dominant forest cover is comprised of coniferous trees, the planting of deciduous trees and shrubs will provide the optimum habitat diversity.

c) Increased wildlife use of reclaimed areas during the early years of vegetation succession can be obtained by providing sufficient cover in the form of travel lanes, to break the "sight distance" of animals in an otherwise open area and to facilitate animal movements between cover and feeding areas. This is of particular importance on sites of linear disturbance such as transmission lines.

4. Habitat losses can also be reduced by designing developments such as borrow pits, access roads and transmission lines to avoid important wildlife habitats such as ungulate winter ranges and riparian habitats. Streams and rivers should be crossed at right angles to reduce the amount of habitat altered or destroyed. Erosion control should be implemented at all watercourse crossings to avoid siltation and degradation of aquatic habitats.

5. Survey and construction activities should be scheduled to avoid important wildlife habitats such as ungulate winter ranges and riparian zones at critical seasons (late winter and spring).

6. Waste disposal procedures should be developed to prevent attraction of furbearers to garbage dumps.

7. Disposal procedures should be developed for industrial-waste to prevent accidental spills and seepage of toxic chemicals into aquatic habitats.

8. B.C. Hydro should assist the Fish and Wildlife Branch to expedite any changes in fur management strategies required to reduce potential impacts of over-harvest of fur and fur-game species due to increased access to new areas.

5.2.2 Mitigation Measures For Furbearer Resource Use

1. B.C. Hydro should establish an exchange of information with trappers whose lines would be affected by the proposed hydroelectric development. Trappers' property should be clearly marked to alert construction crews. This would avoid inadvertent damage or destruction of traplines or equipment caches or the creation of barriers to trapper movements as a result of construction activities.

2. B.C. Hydro should give as much advance notice as possible to trappers of the proposed developments in their trapping areas. This would enable the trappers to move their traps and traplines from areas of construction activity or from the reservoir area and to alter their trapping program to accommodate the changes in animal distribution that will occur as a result of activities. This advance notice should also encourage trappers to identify the location of traplines, equipment caches and cabins to B.C. Hydro planning personnel.

3. B.C. Hydro should apply the Registered Trapline Program (British Columbia Hydro and Power Authority n.d.) to provide compensation to trappers for losses caused by construction activities and reservoir flooding.

4. B.C. Hydro should minimize the potential for theft or vandalism to trapper's cabins, fur, equipment and supplies.

5. B.C. Hydro should assist Fish and Wildlife Branch to expedite any changes in fur management strategies with regard to the potential problems of over-harvest of fur and fur-game species due to increased access to new areas.

## 6.0 SUMMARY

1. A baseline inventory of furbearing mammal populations in the Liard River drainage was conducted for British Columbia Hydro and Power Authority. This study is basically an extension of a previous study of furbearing mammal populations on the Liard River conducted in 1979 by McCourt Management Ltd. (Penner 1979). Data on furbearing mammals were obtained through track-count surveys during December 1980, examination of registered trapline fur harvest records, literature review and discussions with personnel of the B.C. Fish and Wildlife Branch. This information was used to prepare a preliminary impact assessment of the three proposed hydroelectric development schemes on the Liard River and to identify measures to mitigate the potential impacts.

2. Fourteen species of furbearing mammals occur in the Liard River drainage. Seven species (ermine, weasel, mink, marten, coyote, wolf and red squirrel) were recorded during the 1980 track-count survey. Fisher, river otter, lynx and red fox that were recorded during the 1979 track-count survey were not observed during 1980. Wolverine are reported in the fur harvest returns in relatively low numbers. Beaver and muskrat are aquatic species that are commonly reported from registered trapline returns. Black bear and grizzly bear also occur in the study area but are infrequently harvested as furbearers.

Ermine, marten and red squirrel were the most common furbearers recorded during the 1980 track-count survey and had density indices considerably above the average reported for these species in other track-count surveys in the boreal forest.

Marten and red squirrel are also the most abundant animals harvested by trappers. Moderate numbers of mink tracks were recorded during the 1980 survey in comparison to few observed during the 1979 survey. Low numbers of wolf and coyote were recorded during 1980. While lynx were not encountered during the 1980 survey, a moderate lynx harvest was reported in the fur harvest returns for 1979-80. Lynx were the third most abundant furbearer recorded during the 1979 survey. The track-count index shows the abundance of the snowshoe hare population to be moderate during 1980-81 and indicates decline since 1979. The fur harvest records and track-count surveys indicate relatively low populations of fisher, river otter and coyote. Although wolverine were not encountered during the track-count surveys in 1979 and 1980, the fur harvest returns and reports from trappers and Fish and Wildlife personnel indicate a good population in the Liard River drainage. Other mammals recorded during the track-count survey were moose and porcupine.

3. Wolves are rated as common in the Liard River drainage based on the number and distribution of reported observations. The best available estimates of wolf density are one wolf per 110 $km^2$ (Bergerud 1978) and one wolf per 132 $km^2$ (J. Elliot via L. Goulet, pers. comm.). The fur harvest records show that trappers from reporting traplines in the study area harvest an average of 14.6 percent of the provincial wolf catch, considerably greater than would be expected from the proportional size of the study area.

4. Beaver are rated fairly common in the Liard River drainage based on the moderate and consistent catch reported in the fur harvest returns. The total mean annual beaver harvest is 425 pelts. Muskrat populations are fairly low and only expected to be locally common in areas of suitable habitat. The highest muskrat catches are reported from traplines south and west of Lower Post and east of the Rocky Mountains in the Nelson Forks region. The Liard and tributary rivers generally provide poor aquatic habitat for beaver and muskrat. Due to the mountainous terrain, lakes, marshes and slow-flowing streams that are suitable for muskrat and beaver are infrequent.

5. The average number of furs harvested on twenty reporting traplines in the Liard River drainage during the 1973-74 to 1979-80 seasons, is valued at $90,790.15 per year (based on an average of 1978-79 and 1979-80 fur prices). This represents 2.6 percent of the average provincial total for these years; proportionately more than would be expected from the size of reporting traplines in the study area (1.9 percent). The average income per trapline was $4,539.51 (a median income of $4,032.14 and a range of $814.33 to $12,844.49) each year.

6. Marten and lynx were the most important furbearers contributing an average of 36.4 percent and 29.8 percent of trapping income. Beaver contributed an average of 17.7 percent of trapping income. Wolf, red squirrel and wolverine (in order of monetary importance) made up the bulk of the remaining income (11.5%) from the fur harvest. The species of furbearing mammals providing the highest proportion of trapper's income in Eastern and Western portions of the study area were marten (45.7%) and lynx (45.3%), respectively.

7. The main adverse impacts of the proposed hydroelectric development on furbearing mammal populations would occur as a result of habitat loss during vegetation clearing and flooding of the reservoir. These habitat losses would result in a reduction of all furbearing mammal populations in proportion to each species density and the amount and importance of habitat made unavailable. This impact is considered to be of high magnitude and long-term duration. Impacts of moderate magnitude and long-term duration will result from habitat alteration or loss due to dam construction activities, construction of access roads, highway relocation and transmission lines. Impacts of low magnitude and of short-term to long-term duration will result from increased vehicle traffic, construction activities and increased access that will affect furbearers through stress-related disturbances and by direct mortaltiy.

   The reservoirs will be permanent structures, with life spans of many hundreds to several thousands years) and the resulting habitat loss will cause a permanent reduction in the populations of different species of furbearing mammals. The reduction in population sizes would approximate one percent of the regional population (the Liard River drainage) for terrestrial furbearers such as red squirrel, ermine, marten, fisher, coyote, red fox, and lynx and greater than one percent of the regional population for aquatic furbearers (beaver, muskrat, mink and river otter) and species that are seasonally dependent on valley bottom habitats (wolves).

8. The main impacts of the proposed hydroelectric development on furbearer resource use will result from a decrease in furbearer populations and from interference with fur harvesting

activities. Three user groups will be affected: trappers, recreational hunters, and non-consumptive recreationalists. Thirteen trapping areas will be directly affected by loss of trapping area due to reservoir flooding; other trappers will be affected by new access roads and transmission lines. The proposed hydroelectric Schemes will flood approximately 2 to 3 percent of the land area of the affected traplines. New access roads and transmission lines may provide increased access to new areas on some traplines (a positive impact). Other potential adverse impacts include increased access, increased fur harvest, theft and vandalism. Construction activities can interfere with trapping operations through inadvertent destruction or damage to traplines or trapping sets. Construction crews may affect trappers through theft or vandalism of trapper's equipment, supplies, cabins and furs.

9. The most effective measure to reduce impacts on furbearing mammal populations is the selection of the least detrimental hydroelectric scheme. Scheme 8, with three dam sites, was considered to have the least overall adverse impact on furbearers because of the relatively small area flooded by the reservoirs (69,100 ha).

Additional mitigation of adverse impacts include limiting vegetation clearing at intensive land-use facilities, roads and transmission lines, immediate reclamation following construction of facilities, regulation of reservoir water levels to encourage shoreline habitat development suitable for aquatic furbearers, use of appropriate disposal procedures for solid waste and industrial waste and assistance in the development of fur management strategies to protect furbearing mammal populations from over-harvest in newly accessible areas.

10. Mitigation measures to reduce the impacts on furbearer resource use (primarily trappers) include an exchange of information about the development with affected trappers. This would provide advance notice to trappers of impending developments, allowing them to mark or move their equipment and traplines and alter their trapping program. B.C. Hydro should apply the Registered Trapline Program to provide fair compensation for trappers' losses of equipment, cabins, trapping sets or traplines damaged or destroyed by the development. Action should be taken to control construction crews so as to reduce the potential for theft or vandalism to trapper's property. B.C. Hydro should assist the Fish and Wildlife Branch to expedite any changes in fur management strategies to reduce potential impacts of over-harvest of fur and fur-game species due to increased access to new areas.

## 7.0 LITERATURE CITED

Arcon. 1978. Alaska Highway Pipeline Project. Part P - Mammals. Report prepared for West coast Transmission Co. Ltd. by Associated Research Consultants Ltd. 40 pp.

Banfield, A.W.F. 1974. The mammals of Canada. Univ. of Toronto Press, Toronto, Ontario. 438 pp.

Bergerud, A.T. 1978. The status and management of caribou in British Columbia. British Columbia Fish and Wildlife Branch Report. 139 pp.

Brink, C.H. 1964. Spruce seeds as a food of the squirrels *Tamiasciurus hudsonicus* and *Glaucomys sabrinus* in interior Alaska. M.Sc. Thesis. Dept. of Zool., Univ. of Alaska College, Alaska.

British Columbia Fish and Wildlife Branch. 1973. Hunter Sample, Wildlife Management harvest statisitcs No. 8, December 1974. Dept. of Recreation and Conserv., Victoria, British Columbia. 192 pp.

British Columbia Fish and Wildlife Branch. 1974. Hunter Sample Wildlife Management harvest statistics No.10, December 1975. Dept. of Recreation and Conserv., Victoria, British Columbia. 200 pp.

British Columbia Hydro and Power Authority. n.d. Registered Trapline Program. Report prep. by British Columbia Hydro and Power Authority, in cooperation with British Columbia Fish and Wildlife Branch and British Columbia Trappers Association. 22 pp.

Cowan, I.Mct. 1947. The timber wolf in the Rocky Mountain National Parks of Canada. Can. J. Res. 25:139-174.

Douglass, R.J., G.L. Fisher and M. Mair. 1976. Movements and habitat selection of furbearing mammals near Chick Lake, N.W.T. Arctic Gas Biol. Rept. Ser.

Douglass, R.J. and D.R. Wooley. 1974. Preliminary report of monitoring studies conducted at Chick Lake, N.W.T. Arctic Gas Biol. Rept. Ser.

Erlinge, S. 1964. Distribution, territoriality, and numbers of the weasel *Mustela nivalis* in relation to prey abundance. Oikos 25:308-314.

Fish and Wildlife Branch. 1979. Preliminary wolf management plan. British Columbia Fish and Wildlife Branch. 30 pp.

Industrial Forest Service Ltd. 1979. Liard River forest resource and reservoir clearing study. Prep. for British Columbia Hydro and Power Authority.

Keith, L.B. 1963. Wildlife's ten-year cycle. The University of Wisconsin Press, Madison. 201 pp.

Keith, L.B. 1966. Habitat vacancy during a snowshoe hare decline. J. Wildl. Manage. 30(4):828:832.

Keith, L.B. 1974. Some features of population dynamics in mammals. Proc. International Congress of Game Biologists. 11:17-58.

Keith, L.B. and L.A. Windberg. 1978. A demographic analysis of the snowshoe hare cycle. Wildl. Manage. 58. 70 pp.

Kolenosky, G.B. 1969. Aspects of red squirrel *(Tamiasciurus hudsonicus)* population ecology in interior Alaska. M.Sc. Thesis, Univ. of Alaska. 63 pp.

Kolenosky, G.B. 1972. Wolf predation in wintering deer in east central Ontario. J. Wildl. Manage. 36:357-369.

Krasnowski, P.V. 1969. Aspects of red squirrel (*Tamiasciurus hudsonicus*) population ecology in interior Alaska. M.Sc. Thesis. Univ. of Alaska. 63 pp.

Kuyt, E. 1972. Food habits and ecology of wolves on barren-ground caribou range in the N.W.T. Can. Wildl. Serv. 21. 36 pp.

Lincoln, R.C. 1979. Impact assessment on wildlife resources of north-eastern B.C. 1st. Interim Report. Alaska Highway Gas Pipeline Project. Wildlife Resource Assessment Project, Corridors and Linear Developments. British Columbia Fish and Wildlife Branch.

Mech, L.D. 1966. The wolves of Isle Royale. Fauna of the National Parks of the United States. Fauna Series 7. 210 pp.

Mech, L.D. 1970. The wolf: the ecology and behavior of an endangered species. National History Press, Garden City, New York. 384 pp.

Nellis, C.H., S.P. Wetmore and L.B. Keith. 1972. Lynx-prey interactions in central Alberta. J. Wildl. Manage. 36(2):320-329.

Neu, C.W., C.Byers, and J.M. Peek. 1974. A technique for analysis of utilization-availability data. J. Wildl. Manage.38(3):541-545.

Odum, E.P. 1971. Fundamentals of ecology. 3rd. Ed. W.B. Saunders Co., Toronto, Ontario. 574 pp.

Ortolano , L., D.J. Ringel and J.R. Jones. 1973. Environmental impacts associated with reservoir projects. 62 pp. Chapter 5, *In:* L. Ortolano (Ed.), Analyzing the environmental impacts of water projects. A report submitted to U.S. Army Engineer Institute for Water Resources. Nat. Tech. Inform. Serv., U.S. Dep. of Commerce. Springfield, Virginia.

Ostle, B. 1963. Statistics in research. Iowa State University Press, Ames, Iowa. 280 pp.

Penner, D.F. 1975. Peace River Sites C and E environmental impact studies, wildlife resources. Prep. for British Columbia Hydro and Power Authority by Renewable Resources Consulting Services Ltd. 307 pp.

Penner, D.F. 1976. A study of the impact of tar sand development on furbearing and ungulate mammals in the vicinity of Syncrude Lease No. 17. Report I: fall and winter investigations 1975-1976. Prep. for Syncrude Canada Ltd. by Renewable Resources Consulting Services Ltd. 199 pp.

Penner, D.F. 1977. McGregor River Diverison Project, Impact on wildlife resources. Prep. for British Columbia Hydro and Power Authority by Renewable Resources Consulting Services Ltd. 324 pp.

Penner, D.F. 1979. Furbearer studies in the Liard River valley, British Columbia. Report prep. for British Columbia Hydro and Power Authority by McCourt Management Ltd. 121 pp.

Penner, D.F. 1980. Preliminary draft report - wildlife impact assessment, Monkman Coal Project. Prepared for Petro-Canada by McCourt Management Ltd. 173 pp.

Puttonen, R. 1980. Bird and mammal observations on the Liard River, July 6 - October 26, 1980. Unpubl. Rept. 3 pp.

Quick, F. 1953. Wolverine, fisher and marten studies in a wilderness region. Trans. North Am. Wildl. Conf. 18:513-532.

R.L. and L. Environmental Consultants Ltd. 1979. Wildlife sightings - Liard River, 1979. Unpubl. Rept. Prep. for British Columbia Hydro and Power Authority. 6 pp.

Robina, M.A. 1960. Some features of weasel (*Mustela nivalis*) ecology based on observations in the Moscow region. Bjulleten Otbel. Bio. N.S. 65(4):27-33.

Rowe, J.S. 1972. Forest regions of Canada. Dept. of the Environment. Canadian Forestry Service. Publ. No. 1300. 172 pp.

Schultz and Co. 1976. Preliminary environmental inventory of proposed hydro-electric dams and reservoir areas on the Liard River. Report prep. for British Columbia Hydro and Power Authority.

Steel, R.G.D. and J.H. Torrie. 1960. Principles and procedures of statistics. McGraw-Hill Book Co. Inc. Toronto. 481 pp.

Streubel, D.P. 1968. Food storing and related behavior of red squirrels (*Tamiasciurus hudsonicus*) in interior Alaska. M.Sc. Thesis. Univ. of Alaska College, Alaska. 56 pp.

Thompson, D.C., D.M. Ealey, and K.H. McCourt. 1980. A review of the baseline data relevant to the documentation and evaluation of the impacts of oil sands developments on large mammals in the AOSERP study area. Proj. LS26.1.1, Prep. for Alberta Oil Sands Environmental Research Program by McCourt Management Ltd. 121 pp.

Techman Ltd. 1980. Liard River basin vegetation studies. Final draft report prepared for B.C. Hydro and Power Authority by Techman Ltd. and Ceska Geobotanical Research Co. 75 pp.

Van Ballenberghe, V., A.W. Erickson, and D. Byman. 1975. Ecology of the timber wolf in northeastern Minnesota. Wildl. Monogr. No. 43. 43 pp.

Van Zyll de Jong, C.G. 1970. Past and present status of furbearers in Manitoba and an assessment of the needs for furbearer management and research. Manitoba Wildl. Branch. Biol. Rep. 18 pp.

Van Zyll de Jong, C.G. 1975. The distribution and abundance of the wolverine (*Gulo gulo*) in Canada. Can. Field Nat. 89:431-437.

Ward, B. 1979. A study of the impacts of natural gas pipelines on wildlife resource harvesting in northern British Columbia. Report prep. for Westcoast Transmission Co. Ltd., by B. Ward, Management Services. 60 pp.

Wooley, D.R. 1974b. Beaver (*Castor canadensis*) studies in the Mackenzie Valley, 1972. Chapter 2, *In*: R.A. Ruttan and D.R. Wooley eds. Studies of furbearers associated with proposed pipeline routes in the Yukon and Northwest Territories. Arctic Gas Biol. Rept. Ser. Vol. 9.

Wooley, D.R. 1974a. A study of marten (*Martes americana*) in the Mackenzie District, N.W.T. Chapter 3, *In:* R.A. Ruttan and D.R. Wooley (eds), Studies of furbearers associated with proposed pipeline routes in the Yukon and Northwest Territories, Arctic Gas Biol. Rept. Ser. Vol. 9.

Wooley, D.R. and R.L. Wooley. In press. Studies of moose, woodland caribou and furbearers along the Fort Simpson realignment of the proposed Arctic Gas Pipeline. Arctic Gas Biol. Rept. Ser.

# 8.0 APPENDICES

Appendix 1. Comparison of abundance indices (tracks per km-day) of common furbearers in six regions of the study area in the Liard River valley, 1980.

| Survey Region | Tracks per km-day | | | | | |
|---|---|---|---|---|---|---|
| | Ermine | Mink | Marten | Red Squirrel | Snowshoe Hare | Sample Size (km) |
| Site A - Scatter River | 0.69 | 0.04 | 0.90 | 3.54 | 4.02 | 28.5 |
| Toad - Grayling Rivers | 0.22 | 0.23 | 3.40 | 1.82 | 5.18 | 24.9 |
| Norquist - Aline Lakes | 0.71 | 0.26 | 1.97 | 0.62 | 2.13 | 23.5 |
| Trout - Deer Rivers, Liard Hot Springs | 4.94 | 0.18 | 4.23 | 2.21 | 14.17 | 39.8 |
| Fishing Lake | 1.02 | 0.10 | 4.65 | 5.89 | 3.17 | 15.3 |
| Kechika River | 2.36 | 0.08 | 0.57 | 2.34 | 9.19 | 12.3 |
| Average | 2.05 | 0.15 | 2.79 | 2.63 | 7.72 | |
| Total | | | | | | 144.23 |

PRELIMINARY

Appendix 2. Observed and expected frequencies of furbearer tracks/day in different vegetation types on which chi-square is calculated.

| Vegetation Type | Transect Distance (km) | TRACKS/DAY Ermine Obs.[a] | Exp. | Mink Obs. | Exp. | Marten Obs. | Exp. | Coyote Obs. | Exp. | Wolf Obs. | Exp. | Red Squirrel Obs. | Exp. | Snowshoe Hare Obs. | Exp. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spruce forest | 15.71 | 25.9 | 31.7 | 2.1 | 2.4 | 76.6 | 44.1 | 0 | | 0.31 | | 109.5 | 40.9 | 201.1 | 122.9 |
| Black Spruce wetland forest | 6.92 | 0.3 | 13.9 | 1.8 | 1.1 | 6.0 | 19.4 | 0 | | | | 13.0 | 18.0 | 23.7 | 54.1 |
| Coniferous mixed wood forest | 19.00 | 36.7 | 38.4 | 1.0 | 2.9 | 59.3 | 53.4 | 0 | | | | 77.6 | 49.5 | 98.7 | 148.9 |
| Deciduous mixed wood forest | 4.51 | 22.0 | 9.0 | 0.3 | 0.7 | 9.8 | 12.5 | 0 | | | | 8.4 | 11.6 | 0 | 35.0 |
| Deciduous forest | 2.06 | 0 | 4.1 | 0 | 0.3 | 3.5 | 5.7 | 0 | | | | 0 | 5.3 | 0.3 | 15.8 |
| Burn with Lodgepole pine | 9.15 | 20.0 | 18.3 | 0 | 1.4 | 11.0 | 25.5 | 0 | | | | 7.0 | 23.6 | 275.3 | 71.1 |
| Burn with deciduous shrubs | 22.36 | 95.5 | 45.3 | 10.3 | 3.4 | 98.0 | 63.1 | 0 | | 2.0 | | 2.3 | 58.5 | 161.6 | 175.9 |
| Burn with herbaceous cover | 1.46 | 2.0 | 2.9 | 0 | 0.2 | 5.0 | 4.0 | 0 | | | | 0 | 3.8 | 0 | 11.2 |
| Floodplain deciduous forest | 5.46 | 1.7 | 11.0 | 0.4 | 0.8 | 3.4 | 15.4 | 0 | | | | 6.0 | 14.3 | 30.1 | 42.9 |
| Floodplain mixed wood forest | 18.08 | 16.8 | 36.3 | 1.3 | 2.8 | 46.3 | 50.6 | 0 | | 2.0 | | 57.0 | 46.8 | 140.4 | 141.0 |
| Floodplain spruce-fir forest | 24.25 | 36.5 | 49.1 | 1.0 | 3.7 | 48.7 | 68.4 | 0 | | | | 93.4 | 63.4 | 138.2 | 190.6 |
| Riparian tall-shrub grassland | 7.90 | 24.0 | 16.0 | 3.5 | 1.2 | 30.0 | 22.3 | 1.0 | | | | 0.8 | 20.6 | 41.3 | 62.0 |
| Herbaceous and low shrub | 0.79 | 2.8 | 1.5 | 0.3 | 0.1 | 4.3 | 2.0 | 0 | | | | 0 | 1.9 | 0 | 5.6 |
| No cover - wetland | 5.24 | 6.0 | 10.5 | 0 | 0.8 | 2.2 | 14.5 | 0 | | 0.2 | | 0 | 13.5 | 1.2 | 40.6 |
| No cover - disturbance | 1.33 | 0.3 | 2.6 | 0 | 0.2 | 0.7 | 3.6 | 0 | | — | | 0 | 3.4 | 6.0 | 10.2 |
| TOTAL | 144.22 | 290.6 | 290.6 | 22.0 | 22.0 | 404.8 | 404.8 | 1.0 | | 4.5 | | 375.0 | 375.0 | 1127.8 | 1127.8 |
| Statistical significance Chi-square calculated: Tabular value P<0.05=23.7 | | 131.1[*b] | | d | | 96.5[*] | | d | | d | | 176.1[*] | | 794.1[*] | |

[a] Obs. = observed frequencies and Exp. = expected frequencies

[b] superscript notation: * = significantly different at P=0.05, n.s. not significantly different, and d= sample size insufficient for testing

Appendix 3. Observed and expected frequencies of furbearer tracks/day in different terrain types on which Chi-square is calculated.

| Terrain Type | Transect Distance (km) | Tracks /day: Ermine Obs.[a] | Ermine Exp. | Mink Obs. | Mink Exp. | Marten Obs. | Marten Exp. | Coyote Obs. | Coyote Exp. | Wolf Obs. | Wolf Exp. | Red Squirrel Obs. | Red Squirrel Exp. | Snowshoe Hare Obs. | Snowshoe Hare Exp. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wetlands | 39.95 | 49.9 | 80.4 | 8.3 | 6.1 | 62.5 | 112.1 | 0 | | 0.2 | | 21.7 | 103.9 | 64.2 | 312.4 |
| Valley bottom/ Alluvial | 37.06 | 44.1 | 74.6 | 5.53 | 5.7 | 79.4 | 104.0 | 1.0 | | 1.0 | | 110.1 | 96.4 | 324.1 | 289.8 |
| 0 to 10% slope (flat to undulating) | 52.64 | 171.8 | 106.0 | 8.16 | 8.0 | 134.4 | 147.7 | 0 | | 3.3 | | 133.5 | 136.9 | 659.2 | 411.6 |
| 10 to 30% slope | 10.82 | 11.3 | 21.8 | 0 | 1.7 | 75.3 | 30.4 | 0 | | 0 | | 84.3 | 28.1 | 39.3 | 84.6 |
| 30 to 60% slope | 2.16 | 13.5 | 4.4 | 0 | 0.3 | 47.9 | 6.1 | 0 | | 0 | | 25.5 | 5.6 | 32.0 | 16.9 |
| 60+ % slope | 1.59 | 0 | 3.2 | 0 | 0.2 | 5.3 | 4.5 | 0 | | 0 | | 0 | 4.1 | 9.0 | 12.4 |
| TOTAL | 144.22 | 290.6 | 290.6 | 22.0 | 22.0 | 404.8 | 404.8 | 1.0 | | 4.5 | | 375.1 | 375.1 | 1127.8 | 1127.8 |
| Statistical significance Chi-square calculated: | | 91.9[*b] | | 3.0[n.s.] | | 391.8[*] | | d[*] | | d[*] | | 254.2[*] | | 388.8[*] | |
| Tabular value P<0.05=11.1 | | | | | | | | | | | | | | | |

[a] Obs - observed frequencies and Exp = expected frequencies.

[b] Superscript notation: * significantly different at P=0.05; n.s. not significantly different and d=sample size insufficient for testing.

## Appendix 4. Average prices of wild fur in British Columbia from 1970-71 to 1979-80.[a]

| FURBEARER | 1970-71 | 1971-72 | 1972-73 | 1973-74 | 1974-75 | 1975-76 | 1976-77 | 1977-78 | 1978-79 | 1979-80 | Mean of 1978-79 and 1979-80 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Beaver | $ 15.15 | $ 16.85 | $ 18.11 | $ 16.83 | $ 13.53 | $ 19.45 | $ 22.95 | $ 18.48 | $ 36.24 | $ 39.17 | $ 37.71 |
| Muskrat | 1.22 | 1.81 | 2.38 | 2.72 | 2.53 | 4.43 | 4.25 | 4.74 | 5.89 | 6.30 | 6.10 |
| Red Squirrel | 0.37 | 0.59 | 0.93 | 0.87 | 0.80 | 0.72 | 0.75 | 1.57 | 2.56 | 1.47 | 2.02 |
| Ermine | 1.14 | 0.34 | 0.72 | 0.40 | 0.36 | 0.96 | 0.78 | 1.53 | 2.29 | 1.98 | 2.14 |
| Mink | 6.87 | 7.08 | 12.01 | 12.96 | 9.13 | 16.20 | 15.55 | 15.69 | 27.85 | 34.49 | 31.17 |
| Marten | 7.42 | 9.59 | 15.07 | 16.31 | 12.56 | 19.18 | 22.24 | 21.19 | 33.82 | 31.96 | 32.89 |
| Fisher | 22.70 | 28.19 | 33.93 | 49.14 | 38.43 | 75.51 | 105.20 | 95.16 | 170.26 | 148.31 | 159.29 |
| Wolverine | 82.59 | 82.25 | 94.41 | 82.98 | 119.48 | 177.75 | 199.82 | 180.11 | 200.06 | 166.33 | 183.20 |
| River otter | 23.73 | 40.51 | 57.46 | 42.03 | 40.15 | 65.27 | 68.92 | 59.90 | 100.10 | 61.33 | 80.72 |
| Lynx | 23.22 | 39.36 | 86.10 | 93.92 | 131.52 | 259.30 | 224.27 | 315.26 | 382.25 | 214.29 | 298.27 |
| Red fox | 19.07 | 19.34 | 32.82 | 46.40 | 42.22 | 66.57 | 61.80 | 70.39 | 92.88 | 63.29 | 78.09 |
| Coyote | 15.86 | 14.92 | 29.49 | 31.39 | 19.22 | 41.84 | 46.55 | 41.89 | 85.08 | 60.83 | 72.96 |
| Wolf | 57.33 | 50.66 | 57.26 | 82.56 | 84.88 | 90.55 | 116.45 | 105.41 | 145.79 | 107.35 | 126.57 |

[a] Data from B. Saunders, British Columbia Fish and Wildlife Branch, British Columbia.

Appendix 5. Total and average harvest of different furbearers on active traplines in each year during 1973-74 to 1979-80 trapping seasons in the Liard River drainage, B.C.[a]

| Species of Furbearer | Trapping Season 1973-74 Total | Ave. | 1974-75 Total | Ave. | 1975-76 Total | Ave. | 1976-77 Total | Ave. | 1977-78 Total | Ave. | 1978-79 Total | Ave. | 1979-80 Total | Ave. | All Years Total | Ave.[b] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Beaver | 25[c] | 3.1 | 36 | 5.1 | 85 | 10.6 | 65 | 8.1 | 29 | 3.2 | 183 | 20.3 | 458 | 35.2 | 881 | 14.0 |
| Muskrat | 0 | 0 | 9 | 1.3 | 1 | 0.1 | 11 | 1.6 | 1 | 0.1 | 57 | 6.3 | 69 | 5.3 | 148 | 2.4 |
| Red Squirrel | 148 | 18.5 | 123 | 17.6 | 162 | 20.3 | 745 | 106.4 | 79 | 9.9 | 208 | 69.3 | 2474 | 190.3 | 3939 | 62.5 |
| Ermine | 21 | 2.6 | 20 | 2.9 | 3 | 0.4 | 57 | 7.1 | 3 | 0.4 | 6 | 0.7 | 63 | 4.9 | 173 | 2.8 |
| Mink | 18 | 2.3 | 3 | 0.4 | 3 | 0.4 | 14 | 1.8 | 8 | 0.9 | 17 | 1.9 | 36 | 2.8 | 99 | 1.6 |
| Marten | 288 | 36.0 | 94 | 13.4 | 187 | 20.8 | 485 | 60.6 | 447 | 49.7 | 576 | 64.0 | 1258 | 96.8 | 3335 | 52.9 |
| Fisher | 0 | 0 | 1 | 0.1 | 2 | 0.3 | 0 | 0 | 0 | 0 | 1 | 0.1 | 1 | 0.1 | 5 | 0.1 |
| Wolverine | 11 | 1.4 | 4 | 0.6 | 9 | 1.1 | 9 | 1.1 | 5 | 0.6 | 2 | 0.2 | 9 | 0.7 | 49 | 0.8 |
| River otter | 0 | 0 | 3 | 0.4 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 1.1 | 4 | 0.3 | 17 | 0.3 |
| Lynx | 90 | 11.2 | 41 | .9 | 26 | 2.9 | 14 | 1.8 | 12 | 1.3 | 14 | 1.6 | 47 | 3.6 | 244 | 3.9 |
| Red Fox | 3 | 0.4 | 2 | 0.3 | 2 | 0.3 | 4 | 0.6 | 8 | 1.0 | 1 | 0.1 | 5 | 0.4 | 25 | 0.4 |
| Coyote | 4 | 0.5 | 6 | 0.9 | 4 | 0.5 | 5 | 0.7 | 3 | 0.4 | 0 | 0 | 3 | 0.2 | 25 | 0.4 |
| Wolf | 2 | 0.3 | 9 | 1.3 | 8 | 0.9 | 12 | 1.7 | 21 | 2.6 | 11 | 1.2 | 15 | 1.2 | 78 | 1.2 |
| Number of traplines active year | 8 | | 7 | | 9 | | 8 | | 9 | | 9 | | 13 | | 63 | |

[a] These data do not include returns of 9 trapyears from TL21, TL22, TL24 and TL25 for which the season of harvest was not indicated.

[b] Weighted average based on total harvest in all years divided by total active traplines during these years.

[c] Number of pelts.

Appendix 6. Records of wolf observations in the Liard River drainage, British Columbia.

| Checkpoint[a] | Wolf Observations | Data Source |
|---|---|---|
| 1 | Wolf pack of 5 to 6 animals howling near Fishing Lake; summer 1978 | L. Goulet pers. comm. |
| 2 | Single wolf howling, Kechika River; July 1980 | L. Goulet pers. comm. |
| 3 | Pack of 6 wolves; spring 1980 | R. Daloise pers. comm.<br>B. Lincoln pers. comm. |
| 4 | Track of single wolf; December 1980 | This Study |
| 5 | Tracks of 4 wolves on Horquist Lake; December 1980 | This Study |
| 6 | Pack of 4 wolves on the Toad River | S. Willett pers. comm. |
| 7 | Pack of 14 wolves on Liard River at Rapids of the Drowned | S. Willett pers. comm. |
| 8 | Pack of 5 wolves on the Deer River | S. Willett pers. comm. |
| 9 | Pack of 5 wolves on the Coal River | S. Willett pers. comm. |
| 10 | Single wolf (black) on Liard River; October 1979 | R.L. & L. (1979) |
| 11 | Pack of 5 wolves (4 black, 1 gray) in pursuit of moose along Liard River; October 1979 | R.L. & L. (1979) |
| 12 | Single wolf on road to Liard River Lodge; September 1979 | Puttonen (1980) |
| 13 | Single black wolf, shot by trapper; September 1979 | Puttonen (1980) |
| 14 | Wolf sign on Deer River; September 1979 | Puttonen (1980) |
| 15 | Wolf signs along Heule Creek· September 1979 | Puttonen (1980) |
| 16 | Wolf signs along trail from Baldy Mountain to Deer River; October 1979 | Puttonen (1980) |
| 17 | Wolf signs (scats and tracks) observed; May 1980 | L. Goulet pers. comm. |
| 18 | Single black wolf near Lequil Creek; May 1980 | L. Goulet pers. comm. |
| 19 | Wolf signs (scats and tracks) observed; June 1980 | L. Goulet pers. comm. |
| 20 | Wolf signs (scats and tracks) observed; July 1980 | L. Goulet pers. comm. |

| Checkpoint | Wolf Observations | Data Source |
|---|---|---|
| 21 | Pack of 4 wolves on Fishing Lake; February 1978 | L. Goulet pers. comm. |
| 22 | Single black wolf along highway east of Lower Post; August 1978 | L. Goulet pers. comm. |
| 23 | Single black wolf near Liard River Hot Springs airstrip; August 1978 | L. Goulet pers. comm. |
| 24 | Wolf sign observed during summer 1977 | L. Goulet pers. comm. |
| 25 | Liard Plateau including Caribou and Barricade Ranges: reports of a high wolf abundance; outfitter report of a pack of 22 wolves; February 1978. Ministry of Environment report of 2 packs on south end of the plateau | Bergerud 1978 |
| 26 | One wolf pack considered to range in the Norquist-Alpine Lakes area between Lower Devils Rapids and Brimstone Creek | R. Daloise pers. comm. |
| 27 | Wolves reported to be common between the Rabbit and Trout rivers, in the area supporting a herd of about 150 caribou. Outfitters reports of two wolf packs of about 40 wolves | Bergerud 1978<br>R. Daloise pers. comm. |
| 28 | Wolf activity reported abundant along Kechika River Valley and Gemini and Graveyard lakes region and believed to be a wolf pack area | R. Daloise pers. comm. |
| 29 | Pack of 15+ wolves on Graveyard Lake; 1978 | Bergerud 1978 |
| 30 | Four wolf packs are reported in the Toad River Hot Springs area: packs of 14, 9, 13 and 12 wolves (total = 48); on estimated density of 1 wolf per 85 $km^2$ | Bergerud 1978 |
| 31 | Tracks of 10-14 wolves in the Lower Rabbit River; 1978 | Bergerud 1978 |
| 32 | Tracks of 7 wolves in the Upper Rabbit River; 1978 | Bergerud 1978 |
| 33 | Wolf tracks observed; December 1980 | This Study |
| 34 | Wolf tracks observed; January 1979 | Penner (1979) |

[a] Check points are shown in Figure 4.